Shelve: Annual Report of the
Commissioners of Inland
Fisheries . . .

State of Rhode Island and Providence Plantations.

THIRTY-FOURTH ANNUAL REPORT

OF THE

COMMISSIONERS OF INLAND FISHERIES,

Compliments of the

Commissioners of Inland Fisheries.

PROVIDENCE, R. I.
E. L. FREEMAN & SONS, STATE PRINTERS.
1904.

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COMMISSIONERS OF INLAND FISHERIES,

MADE TO THE

GENERAL ASSEMBLY,

AT ITS

JANUARY SESSION, 1904.

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COMMISSIONERS OF INLAND FISHERIES OF RHODE ISLAND.

HENRY T. ROOT, *President, Treasurer, and Auditor*	Providence, R. I.
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Wm. H. BOARDMAN	Central Falls, R. I.

REPORT.

To the Honorable the General Assembly of the State of Rhode Island and Providence Plantations, at its January Session, 1904:

The Commissioners of Inland Fisheries herewith present their annual report for the year 1903:

The work undertaken by the commissioners during the past year may be tabulated as follows:

First. The stocking of our ponds and streams with suitable fresh-water fish, through the distribution of eggs and fry. Page 13.

Second. The collection of definite data respecting the times of arrival and departure of various food fishes, and the preparation of statistics of exportation. Page 14.

Third. The location of fish-traps within the waters of Narragansett Bay, and the collection of statistical data bearing upon their ownership. Page 16.

Fourth. Further investigation of the red-water plague. Page 22.

Fifth. The continued examination of the physical and biological conditions of the waters of the Bay, begun in 1898. Page 23.

Sixth. A continuance of the survey of the shores of the Bay, for the purpose of determining those portions which are most productive of young seed-clams. Page 27.

Seventh. A continued investigation of the life-history of the clam. Methods of artificial propagation and cultivation. Page 28.

Eighth. Preliminary inquiry into the natural history of the Padler Crab (*Callinectes hastatus*), and the soft-shell crab industry in Rhode Island. Page 69.

Ninth. Experiments in lobster-culture. Page 74.

Tenth. The efforts to prevent the illegal taking of short lobsters. Page 83.

Eleventh. The preparation of an exhibit for the Louisiana Purchase Exposition. Page 84.

Your Honorable Body has entrusted your commission with the stocking of the inland waters with edible fish and with the supervision of the fish in these waters, with the conduct of experiments in the propagation of fish and shell-fish, and with the enforcement of laws regarding the capture of fish and lobsters; all of which we believe has been faithfully executed.

The scientific work which was commenced on a small scale in 1897, has, during the past seven years, developed considerable proportions. Each year we have built upon the work of the years before, and recently the experiments have begun to bear fruit in practical results. In work of this experimental character, where every foot of progress is made slowly by breaking new ground, it is important—it is indeed absolutely necessary—that a line of work shall be continued through a long period of time. Too often it happens that excellent experimental or scientific work comes to nothing solely because it is stopped too soon or is frequently interrupted. Your commisssion appreciates the continuous support which has been given by your Honorable Body during these years.

Seven years ago the only material equipment of your commission for scientific work was a small leaky floating "hatchery," a relic of former years when experiments in artificial lobster propagation were attempted. However, the idea of the houseboat as a biological laboratory, and the proof of its effectiveness in experimental work, was of the utmost value. At the present time the equipment consists of an excellent floating laboratory, a small naptha launch suitable for work in the Bay, a small sailboat and three skiffs, a rather disreputable looking but very convenient stranded barge which serves as a storehouse in winter and a dormitory in summer. The laboratory is fitted up with necessary apparatus, including, besides tools, dishes, etc., a stationary gasolene engine and other apparatus for

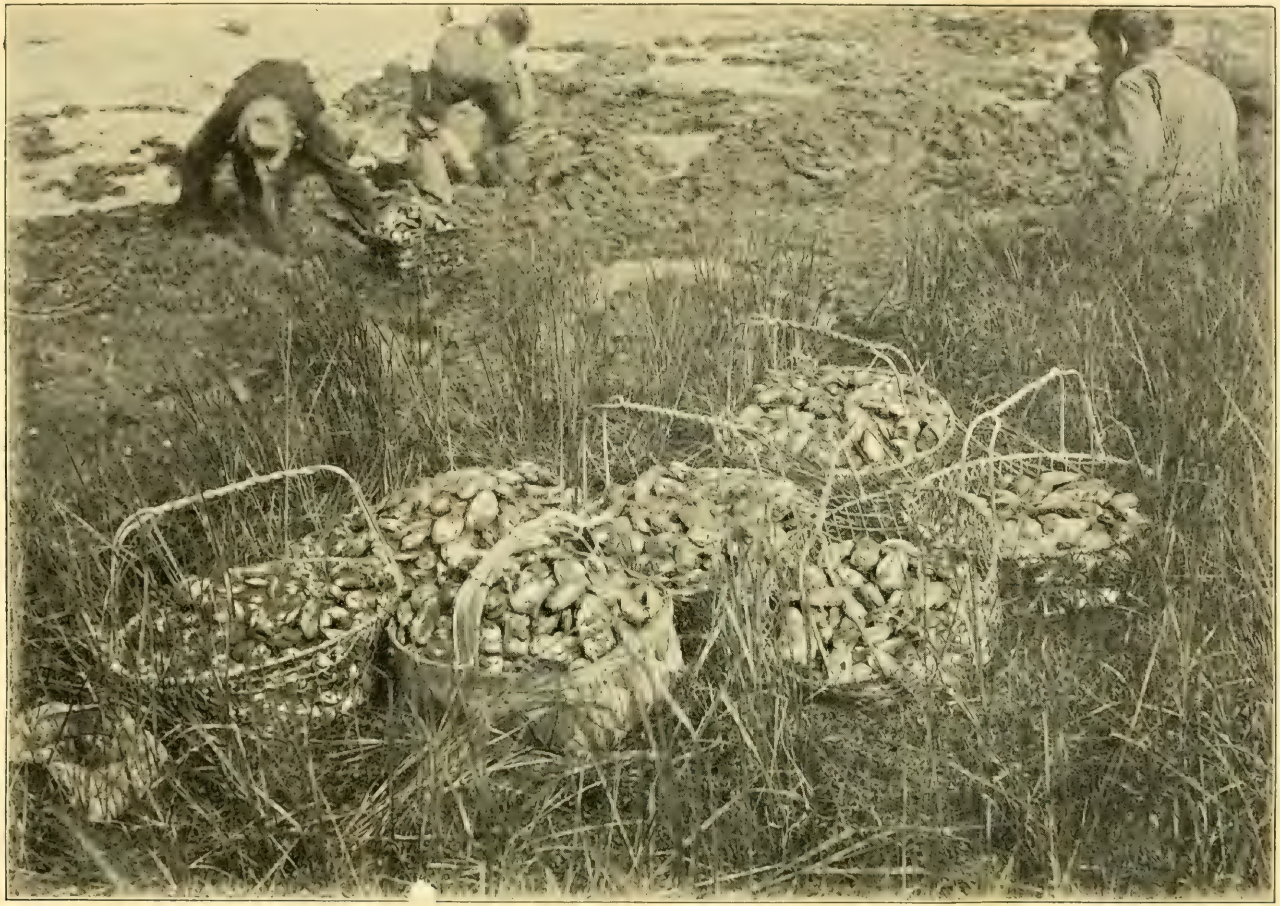

Fig A sample digging from the Commission's bed at Kickemuit river.

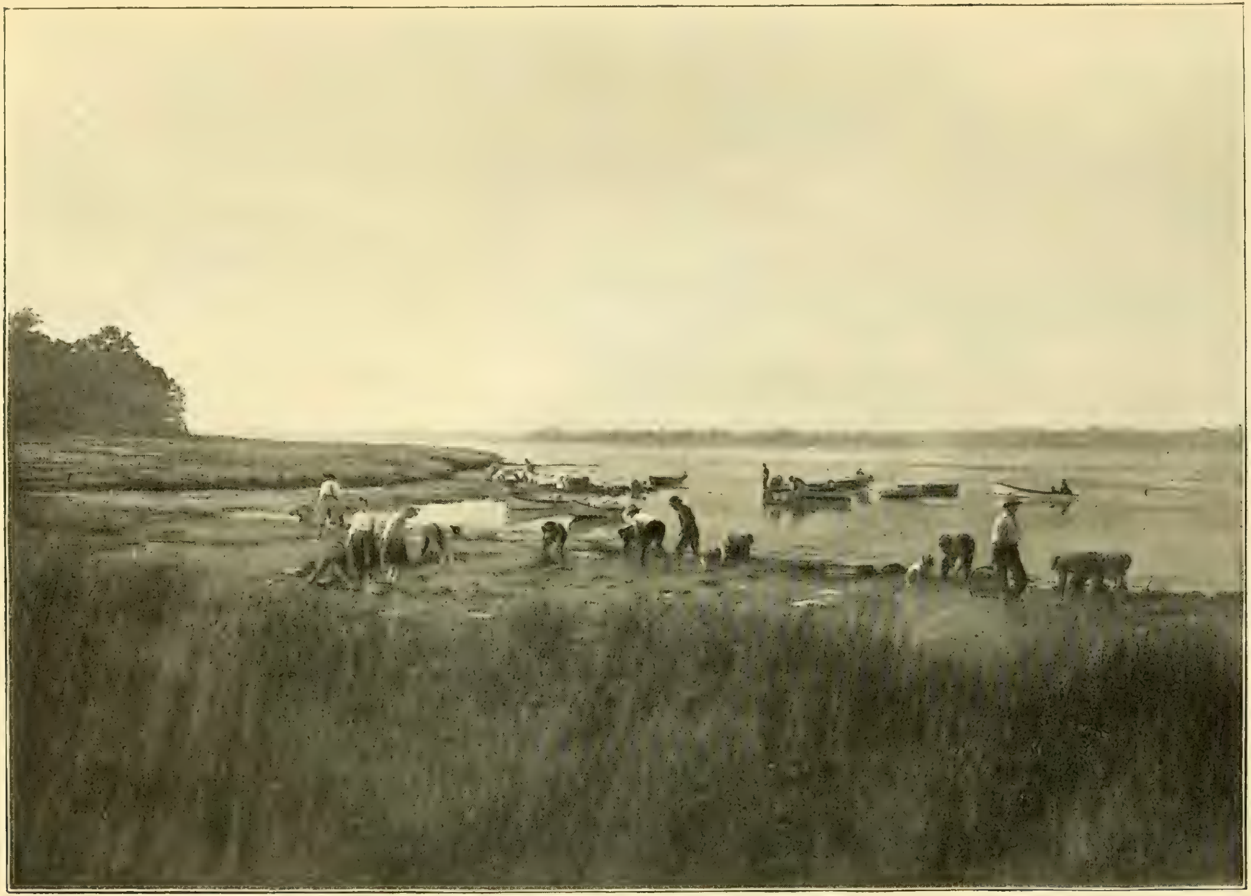

Fig. 2.—Digging clams at the Commission's clam bed, at Kickemuit river.

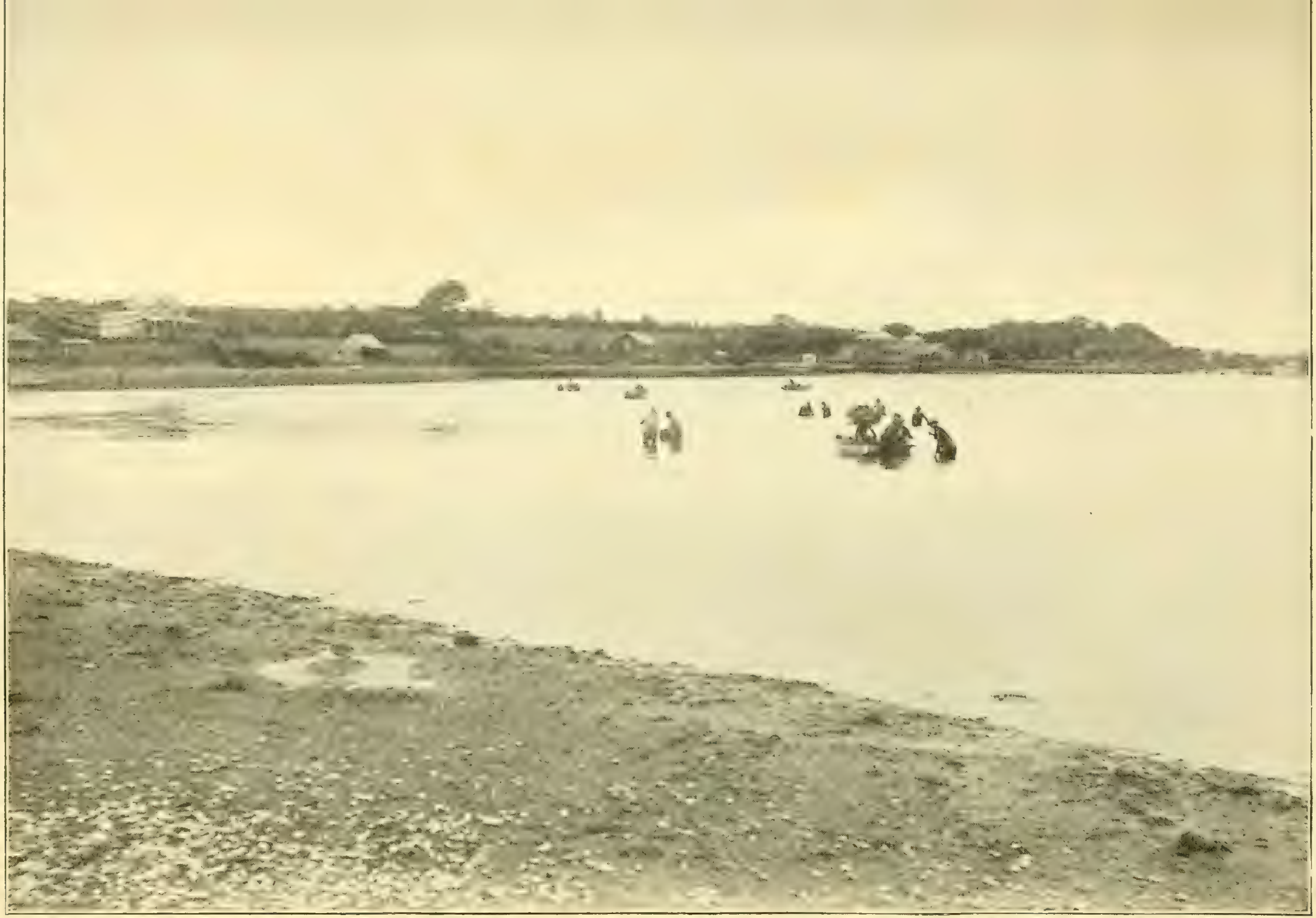

Fig. 3.—Churning clams in the Commission's clam bed at Kickemuit river.

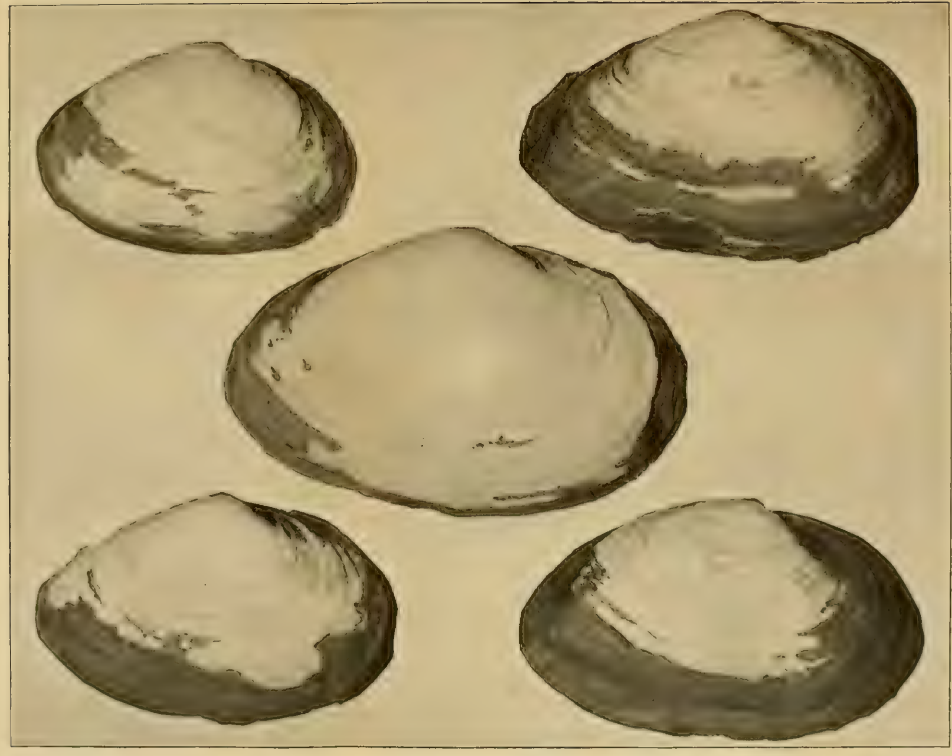

Fig. 4.—Sample clams from the Commission's clam bed at Kickemuit river

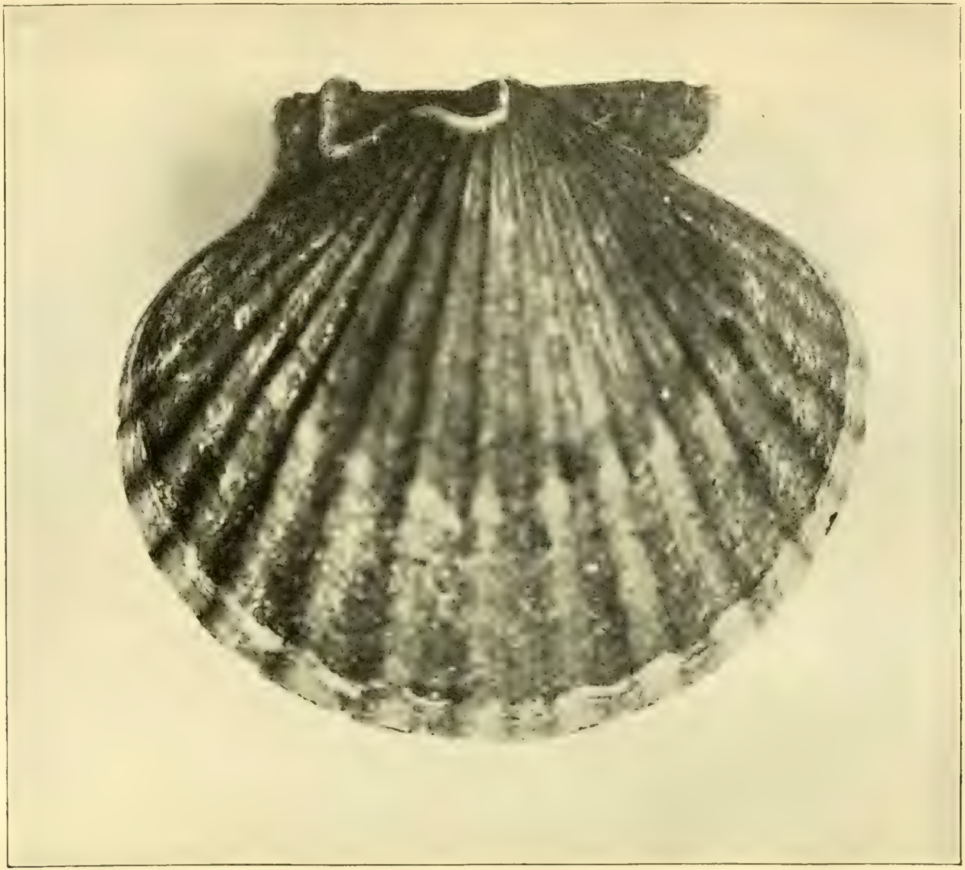

FIG. 5.—Scallop taken October 13, 1903, from Mill Cove, Wickford. Age about two years and four months. This specimen has spawned a second time, as indicated by the second growth ring.

use in hatching and rearing lobsters. Several large floats and numerous cars further contribute to an excellent working equipment. A small cottage, situated near the houseboat, has been leased, which enables the commission to carry on the work during the winter when the cove is full of ice. In the cottage a photographing room has been fitted up. Necessary books and microscopes have been, from time to time, loaned to the commission by Brown University.

The foundation of a Museum of Economic Zoölogy has been laid. A collection of specimens and models arranged to illustrate the important features of the experimental work has been assembled at the office of the commission at the Capitol, and will be exhibited also at the International Exposition at St. Louis.

The body of this Report contains an account of the work of the commission, but there are two or three particular features of this work to which your attention is especially invited. The investigation of the natural history and propagation of the clam has resulted in the first definite information concerning the spawning season, habits of the young clams, the age at sexual maturity, rate of growth and time required to reach a good marketable size, methods of spat collecting, transplanting, etc., and during the past year the first crop of artificially bred clams has been produced. In one of the beds reserved for experimental purposes small seed clams, measuring about 10,000 to a quart, were sown broadcast upon the ground two years ago, and their growth has been observed from time to time. This bed, which contains about one and two-thirds acres, was opened to the public during the past summer, and upwards of six hundred bushels of clams have been taken from it. A sample area of about 300 square feet in this bed yielded 17 bushels, which is equivalent to more than 2,000 bushels to the acre. (See Figs. 1, 2, 3, and 4.)

The most valuable result of the investigations of your commission is a successful and practicable method of raising lobsters through the dangerous swimming period, which immediately follows the hatching of the fry. That this is the crucial point in lobster propagation is universally recognized, and experiments have been made repeatedly by the fisheries boards of the United States, Canada, Great Britain, Germany, Norway, and Denmark for the purpose of discovering a method of protecting the young lobsters through this period. The following extract from an article on the lobster by Dr. Ehrenbaum, of the German Fisheries Station at Helgoland, published in the *Fischerei Zeitung*, July, 1903, strongly emphasizes both the importance and the difficulty of this stage in lobster culture. Having spoken of the egg laying habits and the experiments in hatching, he continues:

"The especially critical period for the later growth of the lobster begins, therefore, as we have seen, with the hatching of the larvæ, and artificial protection must commence here in order to bring the young animals through the most dangerous time of their lives. Unfortunately the efforts hitherto made have met with little success. One can, of course, easily keep away the enemies which feed upon them, but the young animals kept in confinement being necessarily very much crowded, develop such disastrous cannibalism—they eat one another up, even when they are so richly supplied with appropriate food—that hitherto all experiments in rearing them have been wrecked. Those which do not fall victims to this cannibalism enter for the most part the quickly following, but often not smoothly running, moulting process. The Norwegian Appellöf, who has recently conducted especially painstaking researches respecting this point, reports that the first two moults run along smoothly, while enormously great sacrifices attend the two following ones. By the use of the greatest precautions he succeeded in carrying over out of 1,500 larvæ of the second stage, 400 into the third, and 100 individuals into the fourth stage, with which last the life at the bottom begins."

Ehrenbaum continues to the effect that inasmuch as no successful method has yet been devised for overcoming these difficulties in a practicable way, the only thing left to do is to turn overboard the lobsters as soon as they are hatched, as has been done in times past. Your commission has dealt particularly with this problem for several years, and has at last overcome these difficulties and has devised a practicable method of rearing lobsters through this critical period in good proportions, and in such numbers as to be, in our opinion, an actual benefit to the lobster industry.*

The principle, the method, and the plan of the apparatus are new, and essentially different in all respects from those previously used. In a series of eight experiments, in which the fry were counted at the beginning and at the end of the experiments, from 16 to 50 per cent. of the fry in the first stage (not in the second stage, as in Appellöf's experiment) were carried through to the required fourth stage. In the experiment which yielded 50 per cent. 1,000 specimens were used; 40 per cent. were carried through in an experiment with 2,500 lobsters, and over 20 per cent. in an experiment with 5,000 lobsters kept together in a small enclosure.

The advantage which has been gained by the accumulation of material and equipment, and especially by the accumulation of experience and knowledge of working methods, should be followed up. The work of clam propagation should be carried out on a larger scale; the lobster raising methods and apparatus should be perfected, and the next steps in lobster propagation, viz., that of properly distributing and protecting lobsters which have been reared through the critical period, should be further investigated; continued investigation should be carried on in respect to the scallop (see Fig. 5), quahaug, soft-shelled crab, red water, methods of fish hatchery, etc.

One of the most conspicuous needs of our fisheries is a census of the animals and plants which inhabit the waters of the State. We have not at present a complete list of any group of aquatic animals or plants of the Bay, to say nothing of a record of their distribution, abundance, time of arrival and departure, breeding, habits, etc.

It has been said, with prophetic truth, that the ocean is capable of supplying more food for man than the land, and the rapidly increasing productiveness of Rhode Island fisheries at least warrants an effort to find out what our waters contain. Such an acquaintance with our fisheries would be not only of general interest but of economic importance.

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*Since this was sent to press we have learned that unusually large numbers of small lobsters, under eight inches, have been caught in fish traps and shore seines, and dug along the shore during the past year.

State of Rhode Island in account with Commissioners of Inland Fisheries.

1903.	Dr.	
Oct. 3.	To paid for 40,000 yearling trout and distributing same	$1,204 56
Dec. 31.	To expenses of laboratory, investigating clam and lobster culture, quahaug, flat-fish, scallops, and "red water".	3,531 63
	To expenses of deputy commissioners under lobster law	2,632 71
	To printing	23 85
	To expenses of commissioners	407 39
		$7,800 14
1903.	Cr.	
Jan. 2.	By received from State Treasurer	$67 45
	“ “ “ “	87 05
	“ “ “ “	62 00
7.	“ “ “ “	5 05
31.	“ “ “ “	2 00
	“ “ “ “	70 00
	“ “ “ “	11 24
	“ “ “ “	5 10
	“ “ “ “	12 27
Feb. 4.	“ “ “ “	70 50
	“ “ “ “	74 10
	“ “ “ “	63 00
	“ “ “ “	10 00
	“ “ “ “	1 35
	“ “ “ “	54 00
12.	“ “ “ “	16 00
15.	“ “ “ “	6 50
Mar. 4.	“ “ “ “	8 00
	“ “ “ “	57 00
	“ “ “ “	71 35
	“ “ “ “	56 00
20.	“ “ “ “	95 00
	“ “ “ “	40 00
	“ “ “ “	38 64

Mar.	31.	By received from State Treasurer	7	62
		" " " "	2	70
		" " " "	76	70
		" " " "	64	75
		" " " "	40	00
April	3.	" " " "	64	50
	17.	" " " "	2	50
	22.	" " " "	42	00
	29.	" " " "	50	00
		" " " "	81	92
		" " " "	175	00
		" " " "	18	00
May	1.	" " " "	76	05
		" " " "	71	40
		" " " "	1	50
	6.	" " " "	5	00
		" " " "	3	00
		" " " "	72	50
	27.	" " " "	175	00
	29.	" " " "	184	28
June	3.	" " " "	71	25
		" " " "	78	05
		" " " "	71	60
	10.	" " " "	3	52
		" " " "	2	92
		" " " "	11	88
		" " " "	36	37
		" " " "	70	14
	11.	" " " "	45	00
		" " " "	22	00
		" " " "	50	00
		" " " "	44	63
	19.	" " " "	134	99
		" " " "	27	87
	30.	" " " "	3	80
July	1.	" " " "	87	00
		" " " "	78	45
		" " " "	3	59
	2.	" " " "	50	00
		" " " "	29	12

July	2.	By received from State Treasurer	28	00
		“ “ “ “	14	03
		“ “ “ “	16	51
		“ “ “ “	49	00
		“ “ “ “	14	57
	3.	“ “ “ “	6	50
		“ “ “ “	10	00
	8.	“ “ “ “	31	10
	15.	“ “ “ “	30	00
	23.	“ “ “ “	26	15
		“ “ “ “	10	22
	29.	“ “ “ “	110	25
	31.	“ “ “ “	45	00
		“ “ “ “	40	00
		“ “ “ “	40	00
		“ “ “ “	40	00
		“ “ “ “	40	00
		“ “ “ “	15	00
		“ “ “ “	50	00
Aug.	5.	“ “ “ “	161	32
		“ “ “ “	92	10
		“ “ “ “	74	08
		“ “ “ “	6	05
		“ “ “ “	1	75
		“ “ “ “	18	00
	18.	“ “ “ “	74	33
		“ “ “ “	25	00
		“ “ “ “	20	00
		“ “ “ “	5	28
	31.	“ “ “ “	4	08
Sept.	2.	“ “ “ “	2	00
		“ “ “ “	85	30
		“ “ “ “	77	30
		“ “ “ “	4	25
		“ “ “ “	25	83
		“ “ “ “		80
		“ “ “ “	45	00
	4.	“ “ “ “	30	00
		“ “ “ “	40	00
		“ “ “ “	15	00

Sept.	4.	By received from State Treasurer	40	00
	9.	“ “ “ “	68	54
	11.	“ “ “ “	60	00
	25.	“ “ “ “	391	49
		“ “ “ “	33	54
	30.	“ “ “ “	5	65
		“ “ “ “		.70
		“ “ “ “	20	00
Oct.	2.	“ “ “ “	69	23
		“ “ “ “	82	55
	3.	“ “ “ “	50	00
		“ “ “ “	38	48
		“ “ “ “	1,000	00
	7.	“ “ “ “	92	39
	14.	“ “ “ “	6	20
		“ “ “ “	4	00
		“ “ “ “	27	00
	16.	“ “ “ “	25	00
		“ “ “ “	24	22
	27.	“ “ “ “	85	45
		“ “ “ “	83	35
		“ “ “ “	12	00
	31.	“ “ “ “	25	00
		“ “ “ “	15	32
Nov.	18.	“ “ “ “	74	50
	20.	“ “ “ “	75	15
		“ “ “ “	6	20
		“ “ “ “	25	91
		“ “ “ “	17	80
	27.	“ “ “ “	79	15
		“ “ “ “	80	85
		“ “ “ “	41	00
		“ “ “ “	44	70
Dec.	2.	“ “ “ “	31	00
	4.	“ “ “ “	38	45
		“ “ “ “	56	37
	9.	“ “ “ “	7	00
		“ “ “ “	2	25
	30.	“ “ “ “	6	10
		“ “ “ “	210	30

Dec. 30.	By received from State Treasurer	35 00
	" " " "	1 00
	" " " "	1 00
	" " " "	80 00
	" " " "	77 50
	" " " "	4 80
	Total	$7,800 14

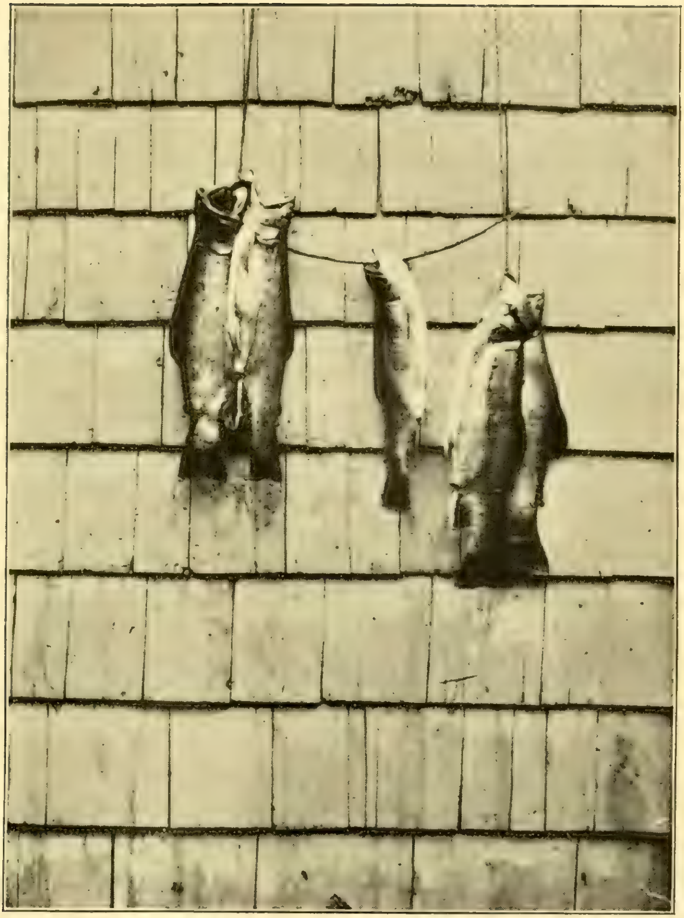


FIG. 6.—A string of fine trout, caught on June 8, 1902, at St. Mary's Lake, Newport. The body of water was stocked five years ago by the commission.

I. THE STOCKING OF OUR PONDS AND STREAMS WITH SUITABLE FRESH–WATER FISH, THROUGH THE DISTRIBUTION OF EGGS AND FRY.

Trout.

Your commission has purchased and distributed, in the various lakes, ponds, and streams of the State, 40,000 yearling trout, and the fishing has been better than for two years past. Among the many reports of good fishing, which are traceable directly to the stocking of the streams, is the following:

On June 8, 1902, a string of fine trout were caught in St. Mary's Lake (Water-works Pond), Newport, which weighed in the aggregate 14 pounds, the largest specimen weighing 3½ pounds (see Fig. 6). On July 30 of the same year another string was caught whose total weight was 13½ pounds. One trout weighing 4½ pounds was taken from this pond on another occasion. This body of water was stocked about five years ago by your commission.

Black Bass.

Through the courtesy of the Hon. George M. Bowers, United States Commissioner of Fish and Fisheries, your commission has procured and distributed in various places several hundred large-mouthed black bass.

In order to promulgate a more general acquaintance with the regulations regarding the taking of fish, your commission has published and distributed a convenient pocket edition of the fisheries laws of the State, and we most urgently appeal to all true sportsmen to discourage illegal fishing, especially in the fresh water streams and lakes.

II. THE COLLECTION OF DEFINITE DATA RESPECTING THE TIMES OF ARRIVAL AND DEPARTURE OF VARIOUS FOOD FISHES AND THE PREPARATION OF STATISTICS OF EXPORTATION.

Table of Fish and Lobsters Shipped From Newport During the Year 1903.

	Barrels of Fish.	Barrels of Lobsters.	Barrels of Crabs.	Number of Sturgeon.	Number of Sword Fish.	Number of Horse Mackerel.
January	793	183		..	..	..
February..........	445	276	..	..	..	..
March............	291	186	..	..	..	..
April...............	1,762	106	..	..	..	..
May...............	16,495	228	4	3	..	..
June..............	17,449	146	7	..	15	..
July..............	7,407	154	7	..	109	9
August............	3,047	125	7	..	24	13
September.........	4,265	21	..	1	16	50
October...........	1,427	20	..	7	..	7
November.........	754	...	..	..	..	..
December.........	247	29	59	..	..	..
Total.........	54,382	1,474	84	11	164	79

Table of Fish, Lobsters, and Sword-Fish Shipped From Newport for the Last Eighteen Years by Regular Transportation Lines.

Year.	Barrels, Fish.	Barrels, Lobsters.	Total.	No. of Sword-Fish.	Barrels, Crabs.
1886...........	....	....	17,434	...	...
1887...........	16,657	834	17,491	...	..
1888...........	15,033	1,161	16,194	.	.
1889...........	19,306	2,047	21,353	..	.
1890...........	8,933	2,650	11,583	...	..
1891...........	18,032	2,204	20,236	...	.
1892...........	26,832	2,123	28,955	..	..
1893...........	24,452	1,399	25,851	...	..
1894...........	17,769	2,392	21,161	...	.
1895...........	24,622	2,119	26,741	...	..
1896...........	20,425	1,728	22,153	143	..
1897...........	25,098	2,039	27,137	45	..
1898...........	34,065	1,163	35,228	74	..
1899...........	34,917	4,143	39,060	162	..
1900...........	38,184	4,793	42,977	166	..
1901...........	50,500	4,393	54,893	21	..
1902...........	53,986	4,342	58,328	179	1
1903...........	54,384	1,474	55,858	164	84

Lobsters Shipped From Newport to the Following Places, 1903:

Taunton, Mass.,
Boston, Mass.,
Fall River, Mass.,
Tiverton, R. I.,
West Baden, Ind.,
Lynn, Mass.,
Brockton, Mass.,
Bristol, R. I.,
Warren, R. I.,
South Framingham, Mass.,
Atlantic City, N. J.,
Rome, N. Y.,
Buffalo, N. Y.,
New York, N. Y.,
Oleans, N. Y.,
Syracuse, N. Y.

The number of boats engaged in the lobster fishery during the season of 1903 was: sailboats and launches, 61; rowboats, 32.

Fifty boats from the city of Newport caught during the year 188,000 pounds of lobsters, the equivalent of about 1,000 barrels.

Of the Bay fishing, with hook and line, there are conflicting opinions, corresponding, no doubt, with individual experiences. On the whole, the sport seems to have been quite as good as in past years.

One notable feature of the Bay fisheries has been the appearance and capture of unusually large numbers of the large "horse-mackerel." Hickory shad have also been reported abundant.

Alewives.

Owing to exceptionally low prices only about 200 barrels of alewives were packed for shipment from Point Judith Pond. About 200,000 fish were sold fresh for bait, and 100,000 salted or smoked for local market.

III. The Location of Fish-Traps within the Waters of Narragansett Bay, and the Collection of Statistical Data Bearing upon their Ownership.

With the publication of the report for 1898, the State first came into possession of definite data respecting the location and ownership of the numerous fish-traps within the Bay and immediately outside, between Sakonnet and Point Judith.

The traps in the Bay are exceedingly numerous for so small a body of water, and it has often been claimed in past years that the too abundant fish-traps would be self-destructive. However this may be, the following table, constructed from the data in possession of the commission, shows that not only has the total number of fish-traps set in the Bay increased remarkably during the past six years, but their increase is seen in every part of the Bay. In certain portions, however, they have increased much more than others. Especially noticeable is this in the Sakonnet river section, where extensive scup fishing is carried on. Here often as many as four and five traps are strung along a single line of leaders, and frequently these "stub" traps are supplemented with an anchor trap in the middle of the river.

Table Showing Number and General Distribution of Fish-Traps.

Year.	Greenwich Bay and Providence River.	East Passage.	Mount Hope Bay.	Off Shore.	West Passage.	Sakonnet River.	Total Number.
1898....	4	15	9	28	29	34	119
1899....	6	15	11	29	28	32	121
1900....	8	11	17	35	32	32	135
1901....	10	15	13	32	32	49	151
1902....	10	14	13	31	42	51	161
1903....	11	17	15	36	44	70	193

A detailed list of the traps is here submitted, together with the location. For further details of location, refer to accompanying chart.

CHART I.

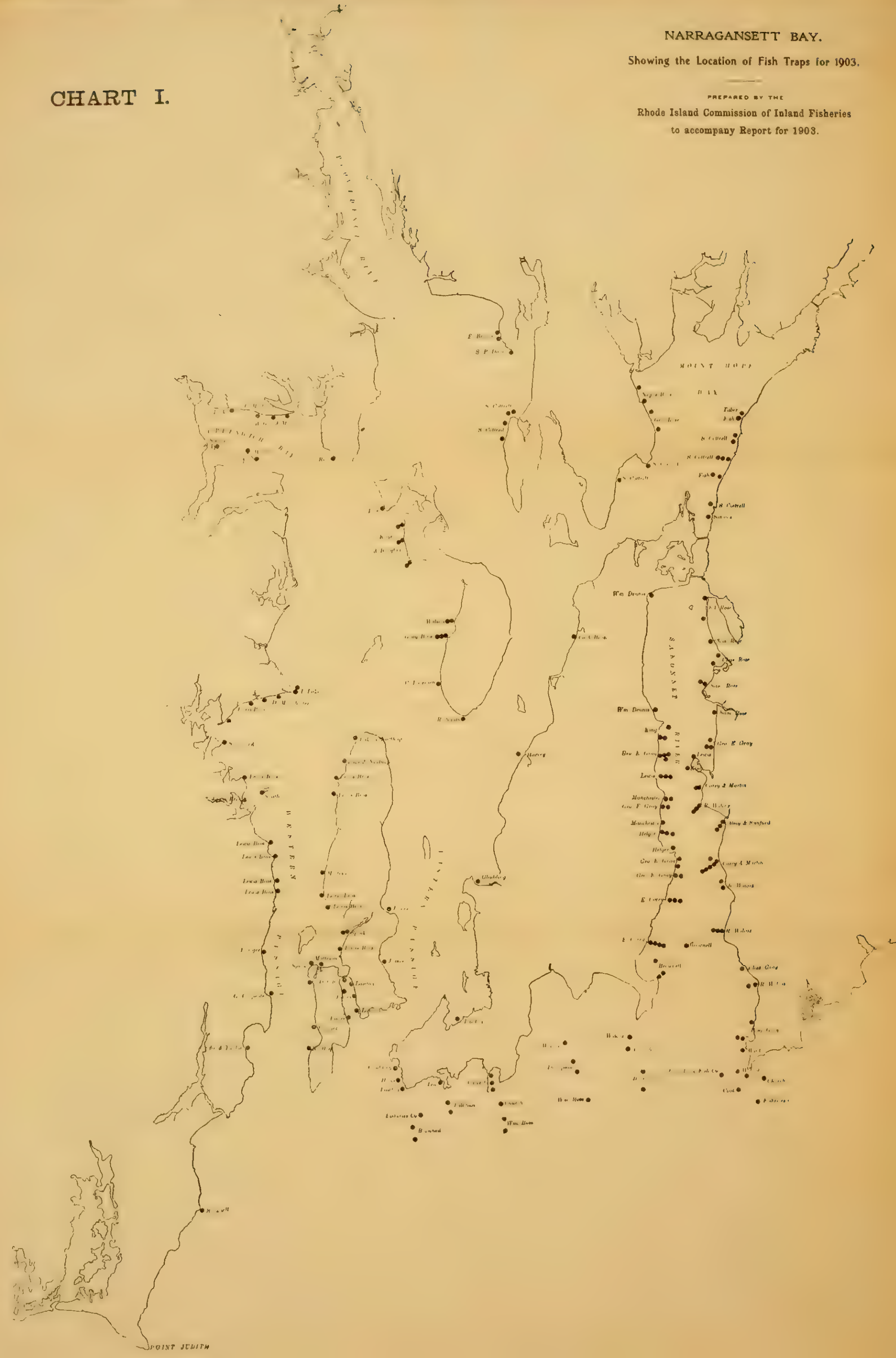
NARRAGANSETT BAY.

Showing the Location of Fish Traps for 1903.

PREPARED BY THE

Rhode Island Commission of Inland Fisheries

to accompany Report for 1903.



Almy and Sanford (000)*	East shore, Sakonnet River.
Brownell, John (000)	West shore, Sakonnet River.
Brownell, John	Mouth of Sakonnet River.
Brown, Edward	West Rumstick Neck.
Brown, Edward	West Rumstick Neck.
Carpenter, George	The Bonnet.
Calvert, George (000)	Spouting Rock.
Corey, Ed. (0000)	Lower west shore, Sakonnet River.
Corey, Ed. (000)	Lower west shore, Sakonnet River.
Corey, George and Martin (00)	North High Hill Point.
Corey, George and Martin (00000)	South High Hill Point.
Corey, George and Martin	South High Hill Point.
Cottrell, S	Popasquash Neck.
Cottrell, S	Popasquash Neck.
Cottrell, S	North Point, Popasquash Neck.
Cottrell, S	W. Mount Hope Point.
Cottrell, S (000)	North Tiverton.
Cottrell, S	North Tiverton.
Cottrell, S	North Tiverton.
Cottrell, S	North Tiverton.
Cottrell, S	Mount Hope Point.
Dennis, Wm	Upper west shore, Sakonnet River.
Dennis, Wm	West shore, Sakonnet River.
Doane, S. P	Rumstick Point.
Easterbrooks, Comer	Price's Neck.
Fish, Clinton (00)	North Tiverton.
Fish, Clinton	North Tiverton.
Gladding, A. B	Castle Hill, South.
Gladding, A. B	Coddington Cove.
Gray, Charles	Church's Cove.
Gray, George E	Lower west shore, Sakonnet River.
Gray, George E. (00)	Lower west shore, Sakonnet River.
Gray, George E	Lower west shore, Sakonnet River.

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*The ciphers in parenthesis indicate the number of traps on a single line of leaders.

Gray, George E. (000)	West shore, Sakonnet River.
Gray, George E. (00)	West shore, Sakonnet River.
Gray Bros. (000)	West Prudence Island.
Griffin & Taylor	Watson's Pier.
Harvey, Charles	North Carr's Point.
Helger, Henry (000)	West shore, Sakonnet River.
Helger, Henry	West shore, Sakonnet River.
Hicks, O. G	Castle Hill, South.
James, Arnold	Mackerel Cove.
James, Arnold	Mackerel Cove.
Kaye & Brayton (00)	West Prudence Island.
Kaye & Brayton (00)	West Prudence Island.
Kaye & Brayton (00)	Pine Hill Point, Prudence Island.
King, Charles	Upper east shore, Sakonnet River.
King, Charles (00)	West shore, Sakonnet River.
King, Charles	West shore, Sakonnet River.
Lake & Northup	Conanicut.
Lake & Northup	Conanicut.
Lake & Northup	Conanicut.
Lake, Isaac (00)	Quonset Point.
Lawton, Ed	Mackerel Cove.
Lawton, Ed	Mackerel Cove.
Lawton, Ed	Mackerel Cove.
Lawton, Ed	Mackerel Cove.
Lawton, Ed	Brenton's Point.
Lawton, J. M	Brenton's Cove.
Lewis Brothers	Scragg Rock.
Lewis Brothers	Scragg Rock.
Lewis Brothers	Plum Beach.
Lewis Brothers	Plum Beach.
Lewis Brothers	Wild Goose Point.
Lewis Brothers	Sauga Point.
Lewis Brothers	Dutch Island Horbor.
Lewis Brothers	Dutch Island Harbor.

Lewis Brothers	Conanicut.
Lewis Brothers	Conanicut.
Lewis, Will (000)	West shore, Sakonnet River.
Lewis, Will	Fogland Point.
Locke, Moses	Buttonwoods.
Lorenzen, C	Southwest Prudence Island
Madison, Peter	Buttonwoods.
Manchester (00)	West shore, Sakonnet River.
Manchester	West shore, Sakonnet River.
Manchester, D	Quonset Point.
Manchester, D	Quonset Point.
Manchester	West shore, Sakonnet River.
Matteson, C	Fox Hill.
Matteson, C	Conanicut.
Negus Brothers	East Bristol Neck.
Negus Brothers	East Bristol Neck.
Northup, Al	Austin's Hollow.
Rice, Herbert H	Warwick Neck.
Rice, Herbert H	Patience Island.
Rose, Charles	Upper east shore, Sakonnet River.
Rose, Charles	Upper east shore, Sakonnet River.
Rose, Charles	Upper east shore, Sakonnet River.
Rose, George	Mount Hope, East.
Rose, George	Mount Hope, East.
Rose, Ed	Upper east shore, Sakonnet River.
Rose, Ed	East shore, Sakonnet River.
Rose, Sam	North Sapowet Point.
Rose, Sam	North Sapowet Point.
Rose, Sam	North Sapowet Point.
Simons, John	Tiverton.
Smith, John	Johnson's Ledge.
Smith, R	South Point, Prudence Island.
Spink, J. W	Dutch Island Harbor.
Spink, J. W	Fox Hill, North.

Sisson, C	Chippanogsett.
Taber, J	North Tiverton.
Tew, R	Price's Neck.
Tourgee, P	Austin's Hollow.
Tourgee, P	Beaver Head.
Tourgee, P	South Saunderstown.
Wilcox, Ralph (000)	South High Hill Point.
Wilcox, Ralph (00)	Church's Cove.
Wilcox, Ralph (000)	East Shore, Sakonnet River.
Wilcox, Ralph (00)	East shore, Sakonnet River.
Wilson & Mitchell	Off Brush Neck Cove.
Wilson & Mitchell	Off Brush Neck Cove.
Wilson & Mitchell (00)	West Prudence.
Wilson, Al	Pojac.
Wilson, Al	Pojae.

Sea Traps.

Brightman, W. J	South Cormorant Rock.
Brightman, W. J	South Cormorant Rock
Brownell, John	Seal Rock, South.
Brownell, John	Seal Rock, South.
Brownell, John	South Cormorant Rock.
Brownell, John	South Narragansett Pier.
Church, D. T. (00)	South Sakonnet Light.
Church, J. B	Off Seal Rock.
Church, J. B. (00)	Off Coggeshall's Ledge.
Church, J. B	South Cormorant Rock.
Church, J. B	West Sakonnet Light.
Church, J. B	South Narragansett Pier.
Cook Brothers	North Coggeshall Point.
Cook, Charles (00)	North Sakonnet Light.
Fisheries Company	Off Seal Rock.
Gray, Benjamin	North Sakonnet Point.
Providence Fish Company	Schuyler Ledge.

Rose, George	Sakonnet Point.
Rose, William	South Cormorant Rock.
Rose, William R.	Off Coggeshall's Ledge.
Tallman, B. (00)	South Cormorant Rock.
Thompson, Noah	Off Seal Rock.
Wait, Benjamin	North Sakonnet Point.
Wilcox, Frank	Off Sakonnet.
Wilcox, Frank	Sakonnet Point.
Wilcox, Ralph	South Cormorant Rock.

IV. Further Investigation of the Red-water Plague.

Little progress has been made during the past season in this investigation, owing in part to the comparative scarcity of the Peridinium, and in part to the stress of work more immediately important.

The phenomenon of red-water has created considerable interest in other parts of the world, and through correspondence with the Japanese Fisheries Bureau we learn that the pearl oyster fisheries of Japan have suffered from the presence of it. Owing to the unusual difficulty of the problem, its life history and causes of its mysterious appearance and disappearance have not yet been completely worked out.

V. THE CONTINUED EXAMINATION OF THE PHYSICAL AND BIOLOGICAL CONDITIONS OF THE WATERS OF THE BAY, BEGUN IN 1898.

Your commission has for a long time felt the need of a thorough biological and physical survey of the Bay, a census which will place on record in accessible form accurate information in regard to the occurrence, distribution, and abundance of animals and plants, the range of temperature, and density of the water, purity of the water, the extent of the shores and the character of the soil in all parts of the Bay. During the progress of the special investigations of the star-fish, clams, scallops, lobsters, etc., the importance of possessing such information has become more and more evident. Success in the artificial propagation of any species, or effective legislation in regard to it, is immediately dependent upon a knowledge of the abundance, distribution, rate of production and natural requirements of the species in question.

These facts as applied to some particular instances are commonly appreciated. No special argument is necessary to convince the oystermen that the oysters and star-fish have intimate relations with one another. The arguments of the scallop and quahaug fishermen in opposing, at public hearings, the leasing of certain new oyster grounds rest upon exactly such facts. The everlasting controversy between anglers and trap fishermen, which has sometimes resulted in the closing of a large industry, is waged over the uncertain effect of trap-fishing on the abundance of the vast schools of migratory fishes whose movements are unknown and whose alternate periods of increase and decrease, extending through many years, are at present absolutely inexplicable. Even well-known international contentions of far reaching significance are based upon unproven theories regarding the migration of fish.

Your commission is not indulging in impossible dreams of a millennium, when all these intricate relationships between animals and plants and their physical environment shall be reduced to mathematical formulas; but we believe in the great resources of Narragansett Bay and other waters of the State, and the investigations which we have made so far substantiate and greatly strengthen this belief. A systematic census so laid out that all facts of known value or of possible importance shall be brought together in accessible form is not impracticable, and would result in great good to the State.

This survey is already commenced. A provisional list has been made of the fishes known to inhabit or to visit the bay, of the invertebrate forms which have been taken on various dredging expeditions and on other excursions, with notes on their abundance and distribution, and of the diatoms found at the surface of the water. The density and temperature of the water has been taken in various parts of the Bay on several expeditions, and regularly at the Wickford station. A daily record of the occurrence of microscopic forms which are taken near the surface of the water has been kept by preserving samples of the "tow" for future reference, the number of unknown forms being so great that at present this is the only possible way of keeping a systematic record. The shores of the Bay have been examined several times in search of clam sets, and general observations on the contour, extent, character of the soil, etc., have been taken. Within the past year a more thorough and systematic survey of the shores has been undertaken. The Bay is divided arbitrarily into a number of sections, and each section is surveyed separately. The declivity of the shore is determined by means of a levelling instrument, and the extent of the area exposed at low tide is calculated. The character of the soil, the presence or absence of ell-grass, sea-weed, and thatch, and the abundance of the clam set are systematically recorded. The data thus collected will be represented as far as possible upon sectional charts for convenient reference. Additional data respecting any of these shore sections—the animals and plants found upon them—their abundance in different years, changes in the character of the shore such as frequently occur, will also be systematically recorded as they are from time to time obtained.

A relief model has been made of Narragansett Bay and the adjacent ocean bed as far south as Point Judith. This model is in plaster, and upon it are shown the configuration of the sea bottom according to all the soundings indicated on the United States government chart of the Bay, and the conformation of the surrounding land and the islands, according to the topographical map issued by the general government. This work has been completed during the past year.

The plan for future work in this survey is briefly as follows:

To continue the survey of the shore in the manner just indicated.

To complete the list of fishes, and to collect all possible data in regard to their migratory movements, their distribution, abundance, food, breeding habits, rate of growth, and the identification of the eggs and young.

To complete the list of invertebrate animals, and to collect similar data regarding them. Facts bearing upon their beneficial or detrimental relations to food animals will be an important part of this subject.

To make a list of the marine plants, with data concerning their occurrence and usefulness.

To make a systematic investigation of the microscopic forms which fill the waters of the Bay and constitute the food of nearly all shell-fish, and of the young of both shell-fish and fish. The young of the clams, scallops, oysters, quahaug, star-fish, lobsters, various species of crabs, and most ordinary fishes, mussels, sponges, jelly-fish, worms, etc., constitute a part of this "plankton," and with them swarm the young and old of hundreds of other species of animals besides the spores of various species of algæ and fungi, and inconceivable numbers of diatoms. The study of these forms must then be conducted from two different points of view: first, as constituting food for most of the edible shell-fish, and directly or indirectly, for all our edible fish; and second, as containing the young of the animals, in which we are especially interested.

The identification of the larval forms which abound in the tow is not only a fascinating field of research, but an extremely important one from the economic point of view. The chief difficulty in the way of the identification of these forms—for our lack of knowledge is not due to our lack of interest—has been to keep alive the unknown larvæ until they become recognizable. The houseboat laboratory has here a great advantage over the usual shore laboratory provided with aquaria. Marine animals of all kinds can be kept alive more readily and develop more normally in the sea than in aquaria.

Point Judith Pond.—During the past year several expeditions have been made to Point Judith Pond, and experiments in transplanting quahaug, clams, and scallops were put under way by residents of the town and by your commission. Mr. Geo. A. Griffin informed us that, during the past season, 2,000 dollars worth of white perch have been packed and shipped, three or four hundred bushels of excellent scallops have been caught, besides flounders, bass, smelts, etc. Some fine river shad were caught weighing seven or eight pounds. The enormous crop of oysters, clams, and fish which has already been reaped from the pond proves the wisdom of the project of opening a permanent breach. The observations on the density of the water and the condition of the plankton also indicate that the pond is capable of supporting an enormous annual crop of other shell-fish, if it can be successfully stocked with them.

VI. A Continuance of the Survey of the Shores of the Bay for the Purpose of Determining those Portions which are Most Productive of Seed Clams.

Beginning in the latter part of July a series of about twenty expeditions was made, to different parts of the Bay, for this special purpose. A large portion of the shore was gone over, and notes were made of the conditions of the new clam set. In one locality only was there found a particularly thick set comparable to that found in various places during several previous years. This one locality, a small area on Cornelius Island, produced, in the latter part of August, 386 clams to the square foot.

The spot on Green's Island, where two years ago there was a phenomenal set, produced this year only a very few scattering specimens.

Why one limited area should produce such immense quantities one year, and not again for several years, is inexplicable at present.

VII. A Continued Investigation of the Life History of the Clam; Methods of Artificial Propagation and Cultivation.

This investigation has been actively continued, and is beginning to produce practical results. Among the new results of the past year is the production of the first crop of clams raised from the seed, and the discovery and application of an accurate and simple method of marking clams which are to be transplanted so that individual specimens can be identified and their growth accurately measured at any later period.

The following special report is a summary of the work of your commission on this subject, and includes the details of the experiments of the past season.

OBSERVATIONS ON THE SOFT-SHELL CLAM.

(*FIFTH PAPER.*)

A. D. MEAD AND E. W. BARNES.

Since the year 1898 investigations have been conducted by the commission in regard to the life history of the soft-shell clam (*Mya arenaria*) and the various economic problems in connection with it.

Although there are questions which still remain unanswered, and new ones are constantly arising, many of the problems which were presented at first have been satisfactorily solved. It seems appropriate at this time, therefore, to bring together the results of the several years' work into a connected account.

The present importance and future possibilities of the clam industry in Rhode Island are not generally appreciated. Narragansett Bay has 250 miles of protected shore line, including peninsulas, estuaries, and islands, and is situated in the central portion of the clam's geographical range. At each ebb of the tide over ten thousand acres of available clam ground are uncovered. Rhode Island is famous for its clambakes, and nowhere in the world are clams more tender and palatable. More than a thousand men depend upon this product of the shore for their maintenance. The shores do not now yield the abundance of clams which they did in former years, but we believe that the production can be increased, not only to its former amount, but far beyond it.

The subject will be discussed according to the following outline:

Part I. Life History and Habits.

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PART I. LIFE HISTORY AND HABITS.

THE SPAWNING SEASON.

The eggs of the clam, which are extremely minute, are extruded from the siphon, or snout, of the female clam into the water, where they are fertilized by sperm which the male clam extrudes in a similar manner.

The spawning season proper extends throughout the latter part of May and the whole of June, and sometimes into the first of July. At this season the great majority of the eggs are laid.

Mature clams which were examined on the 8th and 12th of May, 1899, were found to have their sexual organs full of nearly ripe sexual products. On the 18th, and again on the 20th, artificial fertilization was attempted, and, although only from ten to twenty per cent. of the eggs were found to develop normally, at no time of year has artificial fertilization of the clam been more successful. These results were confirmed in the following year. This, and the fact that the swimming young were found at this season, shows that the clams were ready to breed during the last of May. The spawning season, however, apparently reaches its height about the middle of June, and clams examined after this time are found, in most cases, to have extruded their eggs; by the first of July the set on the shore is excellent.

There is no doubt, however, that the clam also spawns to some extent throughout the summer and probably until late autumn. This has been proved by the discovery of the very small clams along the shores and in the spat collectors at different times of the year. The clam is not unique in this respect, for many other species, which have a regular breeding season, are known to spawn to a greater or less extent at all times of the year.

In the early spring of 1901, 1902, and 1903 there were discovered sets of clams less than one-quarter of an inch long, which were distinguished from those of the summer sets by having the umbone (that portion of the shell nearest the hinge) raised in relief from the rest of the shell, and showing by its corrosion that the clams had lain for months (i. e. during the winter) with almost no growth. The small size of the clams during this dormant period, as indicated by the corroded part of the shell, was ample proof that they could not possibly have set during the previous summer; for the clams of the previous summer's set averaged 25 mm. (1 inch) in length at the commencement of winter. Throughout the summer the clams of the fall set were readily distinguished from those which set in the spring. Along the shore, this fall's set would scarcely be noticeable, but in the commission's spat collector at Rumstick there were, in the middle of January, 1903, more than one hundred to the square foot. At Kickemuit river, in a spot very favorable for clams, there were at this time hardly more than two or three to the square foot. According to the observations of the last five years the clams which set at any time other than the early summer seem to be of little economic importance.

THE FREE SWIMMING PERIOD.

The eggs of the clam, after being fertilized in the water, develop into free-swimming larvæ which are carried by the tides and scattered in all directions. In this stage they are barely visible to the naked eye. When examined under the microscope they are seen to resemble the adult clams in the possession of a pair of hinged shells, but differ widely in shape and structure. This is very unfortunate for the investigator, because the oyster, quahaug, scallop, and other bivalves breed about the same period, and these also have free-swimming larvæ, which in many cases closely resemble those of the clam. A close study of these forms, however, enables one to distinguish by one means or another, the oyster and the scallop from the clam, and doubtless sufficient investigation would enable one to identify, all the forms. For positive identification certain of these free-swimming larvæ, which were supposed to be clams, were kept under observation until they lost their swimming organs and took on the form which could be recognized readily.

In collecting the clams of this stage a silk bolting-cloth tow-net, which has an extremely fine mesh, is used, and from the first of June until the middle of July these minute clams can be obtained every day by dragging the net along the surface of the water. In order to separate them from the many other small organisms, the dish of sea water into which the contents of the net have been emptied is gently tapped. The clams immediately close their shells and sink to the bottom. The top water is then drawn off, some clear sea water is added, and, whenever the clams are desired, they can be precipitated to the bottom by tapping the dish, and then transferred by means of a pipette to a watch glass under the microscope. As one watches these specimens under the microscope, very frequently he will see one of them open its shell, thrust out and expand a circular swimming organ (*velum*), and go whirling about through the water; then suddenly draw in the velum, close the shell, and fall to the bottom.

Some specimens larger than the average, have the foot and siphon well developed, and, when watched under the microscope, are seen to crawl about rapidly, by means of the foot, instead of swimming. The swimming organ gradually disappears while the foot grows, and, at a certain stage, they alternately swim and crawl. The foot soon becomes proportionately very large, and it is not impossible that the clams may sometimes use it in swimming, though this has not been observed.*

The clams often swim about very freely for a week or two after they are captured. Then they lose their swimming organs, the siphon and foot are developed, the shell changes in shape, and the larvæ assume the unmistakable characteristics of the species. Up to this time the transparent shell allows the internal organs to be plainly visible.

The growth at this period is very remarkable. Exactly how fast they grow under the natural conditions is not known, but those which were kept in a dish of water, where the supply of food was meagre as compared with that in the tide water, and where other conditions were necessarily artificial, grew to ten or twelve times their original length in less than two weeks.

The principal changes which may easily be observed in the clam are the elongation of the shell (the outline at first being very much rounded), the increase in the number of gill plates, and the relative lengthening of the foot.

THE ATTACHMENT PERIOD.

The free-swimming period usually ends late in June or early in July. If the eel-grass and sea-weed are carefully examined at this time, large numbers of these little clams may be found hanging to the stalks by the slender gelatinous threads. They attach themselves also to driftwood, spiles, stones, etc. This thread (the byssus)

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*The razor clam (*Ensatella Americana*) has this ability even after it has attained the length of three or four inches, although its foot is aided by forcing backward of water through the mantle opening. On one occasion a large number of specimens about one-quarter of an inch long were caught at the surface.

is elastic and yet very tough, like that of the mussel, and arises from the byssus gland which is situated on the ventral side of the foot near the extreme posterior end. It is an entirely homogeneous structure, and is usually single throughout its entire length, but sometimes near the end it divides into two or more branches. The clam has the ability to free itself from attachment and to form a new byssus at will.

The clam at this period may be recognized readily by its shape, yet it differs in the following manner from the adult. The outline is more rounded, and the umbones are more prominent and farther apart. The foot is very long and capable of quick movements, and extends over the entire surface ventral to the visceral mass, while in the adult clam it is hatchet-like and protrudes only from the extreme anterior end of the visceral mass. The siphon (snout), while quite like that of the adult in shape, is relatively much smaller, and consequently the shell does not gape open so much posteriorly. The siphon, like the foot, is more easily and rapidly protracted and retracted than in the adult.

The growth of the clam is still very rapid, and it is during this period that it assumes the shape of the adult. One remarkable fact in this change is the double shiftng of the position of the umbones, or hinge prominences. It will be recalled that, in the adult clam, the position of the umbones is nearly central. This is also the case with the very small clam, but, through an increased growth posteriorly, the umbones become shifted more and more anteriorly till the clam is about 6 mm. long; then, by increased anterior growth, the umbones again gradually assume a central position.

The duration of this attachment period seems to depend, to a certain degree, on the environment. Certainly it is not dependent entirely on size, for frequently clams measuring half an inch in length are found attached. The great majority, however, reach the ground and burrow long before attaining this size. The byssus is retained some time after the clam has left its place of attachment and has buried itself in the soil; by means of it the clam attaches itself to grains of sand within its burrow and thus anchors itself.

THE COMMENCEMENT OF BURROWING.

Clams begin to burrow as soon as they find a favorable location. This may be soon after they cease swimming, or, if they have a chance to settle upon sea-weed or other objects not near the ground, it may be weeks before the burrowing actually begins. Even after they have burrowed, they seem for a time to be restless, and, as first observed by Kellogg, the small clams, even those sometimes an inch and a half in length, will leave their burrows without apparent reason and wander about. Kellogg saw one such specimen try six different places in three days. Usually before they reach this size, however, they are permanently located and evidently satisfied to pass their allotted years in one place. The period of commencement of burrowing is a critical one for many reasons. The young clams cannot live far below the surface, and though they may anchor themselves within their burrows, they are still liable to be washed out by storms, crowded out by their neighbors if the set is very thick, or dug out by crabs, eels, duck, and other enemies. It often happens, too, that localities which are particularly favorable for setting are entirely unfit for subsequent growth. Specific instances have not infrequently come to our notice in which abundant sets have practically been exterminated by decaying sea-weed or shifting sand.

GROWTH AND AGE AT SEXUAL MATURITY.

Just how long the clam lives has not yet been determined, owing to the difficulty in finding reliable marks of age. The growth during the first few years has been carefully traced in our experiments, and it is evident that the growth becomes slower with advancing age. Considering the very large size of clams frequently found in flats which are exposed only at extremely low winter tides, together with the relatively slow growth of old clams as shown in other observations, it would seem that clams, like some other marine animals, may live until some accident deprives them of life. Some of the clams raised from the seed at the Wickford Experiment Station are now in their fourth year, and do not show any signs of degeneration.*

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* For definite data concerning the rate of growth, refer to page 54.

PART II. QUESTIONS OF ECONOMIC IMPORTANCE.

The purpose of the inquiry into the life history and habits of the clam has been to ascertain how to control the conditions upon which the yield of clams depends. The scientific results have indicated the solution of the practical problems at every step. From the economic point of view there are two general problems, viz., the causes of the present depleted condition of our clam flats, and the means of restoring or increasing the natural yield.

PHYSICAL CAUSES OF THE DEPLETION OF THE CLAM BEDS.

In view of the many adverse physical conditions and natural enemies with which the clam has to contend from the time the egg is laid until maturity, the chances of an individual's reaching the adult condition would seem to be almost infinitesimal. The minute, unprotected eggs, extruded wherever the female may happen to have burrowed, lie upon the ground or are swept into the current, and there await the arrival of the spermatozoa which are extruded into the water by the male. It is, of course, impossible to say how great are the chances of non-fertilization.

When the eggs have developed into swimming larvæ they are still at the mercy of the tides; they may be carried out to sea or lodged in muddy, rocky, or otherwise impossible places. Those which have successfully set and even burrowed may still be destroyed by shifting sand or silt, or washed out of their burrows and exposed to their many enemies. At times clams, an inch or more in length, are found dead in immense numbers, apparently from the effects of the excessive heat, where the shore is underlaid with hard clay and covered with a thin layer of sand in which the clams have burrowed. At Pawtuxet, during the past year, great quantities of clams were found dead, and several visits to the flats failed to reveal any other cause than the one just suggested.

Not infrequently clams in a particular region appear to die of an epidemic disease that cannot be referred to the heat. Some small experimental beds at Wickford were completely destroyed in this way, the clams dying, all nearly at the same time, and rotting in their burrows. The subject of clam diseases has yet to be investigated.

On one occasion, at least, the presence of the red-water in great quantity seems to have been the direct cause of the destruction of vast quantities of clams. About the first of October, thousands of bushels of clams about an inch in length were washed ashore on the beach about an eighth of a mile north of the Rhode Island Yacht Club, at Pawtuxet, and when they were examined a considerable portion of them were still alive. There had been, of course, no excessive heat, and no storm of sufficient violence, in our opinion, to wash the clams out of their burrows; but there had been, recently, a phenomenal quantity of peridinium in that vicinity, and we are strongly inclined to believe that the latter were the cause of this wholesale destruction. It is, indeed, characteristic of most animals, shrimp, crabs, flatfish, etc., in the presence of this plague, to endeavor to come to the surface, and when they are first washed ashore they are, as a rule, still alive.

NATURAL ENEMIES OF THE CLAM.

Clams are beset, from the very beginning, by numerous enemies. The eggs and free-swimming fry furnish food for many varieties of fish, mollusks, crustacea, etc. As soon as they cease swimming and commence to burrow, the young star-fish, mummychogs, crabs, and "oyster drills" feed upon them.

It is the universal verdict of fishermen that the paddler crab (*Callinectes hastatus*) is a most serious menace to the young clams; and, though experiments have been tried with this species, which have given only a negative result, the rock crabs (*Cancer irroratus*) were found to dig up and eat clams of considerable size. In one of our experiments four of these crabs dug up and made way with twenty-one fair sized clams in the course of two weeks.

The Sea Snail (*Neverita duplicata*). Often along our shore clam shells are found with holes neatly bored through them, usually near the hinge, which resemble those frequently found in quahaug shells. The latter are easily traced to the "cockle," or sea snail (*Neverita*). It would be natural, judging from the similarity of the perforations in the shell of the clam and the quahaug, to assign them both to the same cause, except for the fact that clams lie buried in from six to twelve inches of soil, while the *Neverita* and quahaug are usually found near the surface. The *Neverita*, however, actually burrows after the clams, and a specimen was found at Wickford six inches deep in the firm soil in the act of boring a clam. The hole had been drilled about half way through the shell. Following this discovery some experiments were made to test the matter further. A *Neverita*, placed in an inverted orange box over one of our clam beds, bored and devoured seven good sized clams in two weeks, and, at the end of the experiment, was found five inches deep in the soil.

The *Neverita* are not, perhaps, numerous enough in our bay to be a very serious injury to the clam product, but in Plymouth, Mass., they are excedingly abundant and are collected and sold for bait. In the year 1901, 8,000 buckets of these animals, which go there by the name of cachels, were collected and sold at Plymouth. They bring from sixty to seventy-five cents a bucket, and the catch, therefore, amounted to nearly 6,000 dollars. During the past year about 4,000 bushels were "picked."

There are other gasteropods which drill holes in the shells of clams, especially in the young ones; for example, the oyster drill (*Urosalpinx*). Those clams which have come to the surface of the ground or have been forced out of their burrows are especially attacked by these animals, and often the shores are strewn with the bored shells. The holes can easily be distinguished from those bored by the *Neverita* on account of their small diameter. Fig. 7 is from a life size photograph showing a series of bored clams, the work both of the oyster drill and of the *Neverita*.

Man as an Enemy of the Clam.—After all has been said concerning the physical conditions and destructive enemies of the clams, the proposition remains that the clams continued to hold their own in abundance along our shores until a comparatively recent date. Though the chances of death of individuals are so great, nature has provided an ample protection for the species in the tremendous productivity of the clam. Were the chances against reaching maturity millions to one (and they probably are), the eggs are laid in sufficient abundance to offset them.

But in recent years the clams have not held their own, and the decrease is, without question, the direct result of the promiscuous, unlimited, and unreasonable digging by man. There is no evidence that the physical conditions or natural enemies have recently become more destructive, nor can more than a small part of the responsibility be laid at the door of the manufacturers who allow detrimental waste products to pour into the bay. The decrease is quite as well marked in regions where the water is good and where clams, if left to themselves, thrive well. The decrease has been assigned also to such causes as the wash of steamers which ply the waters of the bay more frequently and more rapidly than in former years, but the same answer applies to this suggestion, viz.: the clams have decreased on shores which are not washed by the swell of steamers. But where is the square yard of shore, known to contain clams, which has not been dug over and over again, and all the clams found, which were more than an inch and a half long, taken out? Not only are all the clams of edible size taken, if discovered, but the smaller ones are, many of them, buried deep or washed out and left exposed to natural enemies.

The practice of continually digging the shores is defended by many clammers, on the ground that it is good for the clams or even necessary to their growth, but our observations and experiments argue against this proposition, except in rare cases where the set is so exceedingly thick that the individuals actually crowd one another. Time and again in experiments on a small scale, and in some larger experiments, like those at Kickemuit river and Wickford, clams have been planted and left undisturbed and have grown remarkably well. See page 67.

It is a belief almost universally held that the soil loosened by much digging is rendered favorable for the setting of clams, but even this proposition our experiments contradict. The remarkably thick natural sets of small clams found in different years were, in every instance, upon shores which contained so few old clams that they were not dug over. For example, the point of Cornelius Island, at Wickford, yielded 12,500 clams to the square yard; the point at Old Buttonwoods, in 1900, yielded nearly as many; the east shore of Green's Island in 1891, yielded about 8,000 clams to the *square foot;* the same point on Cornelius Island, again in 1900 yielded 7,715 clams per square yard. These areas of shore were, at the time when the clams set, lying undisturbed. On the other hand, we have not found sets nearly so dense in any area which had been dug over, although of course good sets have been deposited in such places. Again, in the commission's bed, at the Kickemuit river, which rested undisturbed for two years, not only was there an excellent product from the clams which were sown, but there was also a heavy set of new clams.

We are convinced that the clam in Narragansett Bay can, at the present time, as in the past, hold its own against natural enemies and adverse physical conditions, and can regain and maintain its former abundance, and, moreover, that excessive digging is the immediate cause of the decrease of the product.

METHODS OF INCREASING THE YIELD OF CLAMS.

In developing methods of clam culture we have constantly kept in mind two possibilities: that of reinstating the clams on the shores for public digging, and that of cultivating them on grounds leased to private parties. Success in either case must obviously depend on the degree to which unfavorable conditions of life are reduced and favorable ones increased.

Increase in the Production of Spawn.—That the general increase in the amount of spawn and the chances of fertilization would follow a general increase in the abundance of adult clams is self evident. Experiments in artificial fertilization have been tried many times and a sufficient number of eggs were fertilized for working out the early stages of development, but as a practical method it does not yet give promise of success.

The Increase in the Production of the Set.—A good deal, we believe, can be accomplished at this point. It is a significant fact that the water is, at certain times of the year, swarming with clam larvæ ready to set. A phenomenon witnessed almost every year of remarkably thick sets in certain limited areas, and the fact that equally thick sets have been caught by artificial contrivances in places where the natural set was sparse, shows that favorable conditions at the place of setting is the most important factor, and probably one which may be, to a certain extent, controlled.

Of the spat collectors referred to, two forms have worked successfully. The first, described more fully in the report for 1900, consisted of a small, square, bottomless box, 12 by 14 inches in diameter, set firmly into the ground near the low-water mark, and covered with a fine galvanized wire netting, "pearl cloth." The swimming fry apparently hit upon the netting and fall to the ground, and, if they rise again as far as the netting, they are apt to be again precipitated. In this box we caught about 15,000 clams. Another successful form is that installed at Mr. Alexander's estate, on Rumstick Point (described and figured in the last report). It consists of a sand-filled box with a wooden cover provided with a window of pearl cloth and bored with numerous small holes. A large number of clams have been caught in this apparatus.

The Protection of Spawn and Swimming Fry.—To protect the spawn and swimming fry from adverse physical conditions and natural enemies is, as far as we know, impossible. These microscopic creatures are carried hither and thither, according to the condition of tides and winds, light and darkness, heat and cold—for they doubtless rise and sink in response to changes in light and in temperature like many other minute swimming forms. They are no more likely to return to the flats where they were produced than to settle in distant places, and, therefore, a man who should keep a bed of breeding clams would not benefit himself any more than his neighbors. We cannot control these conditions, and no more can we control the activities of the myriads of minute animals which feed on the swimming clams, such, for example, as the worm larvæ, copepods, crab larvæ, and hundreds of species, not commonly known, which abound in the waters of the Bay.

Protection of Spat.—When the clam is finally set and the spat begins to burrow, something can be accomplished toward their protection; chiefly, however, by protecting them from the clam hoe, and in transplanting them when they have set too thickly.

TRANSPLANTING.

A large number of experiments have been conducted, during the last few years, which have demonstrated that it is perfectly feasible to transplant clams and have given definite information in regard to the following points: the best size for planting, the methods of collecting and caring for the seed between the time of collecting and planting, the value of different soils, the methods of planting, the rate of burrowing, the rate of growth, and the like.

Best Size for Transplanting.—Clams of any size, from one-eighth of an inch to five inches in length, can be, and in our experiments have been, successfully transplanted. The smaller sizes, one-half inch more or less in length, are best for several reasons: They can usually be obtained more easily than the larger ones, and they burrow more rapidly and more surely; they can, indeed, be sown upon the surface of the ground, like oats, so great is their capacity for burrowing. This burrowing power decreases with the size of the clam. The growth of the young clams is much more rapid than that of the old ones. Finally, if they are left undisturbed, they grow to a large size, with a handsome shell, even and smooth.

Methods of Collecting Seed.—Where the small clams can be found in great abundance there is no difficulty in procuring seed by the use of large sieves. In three of the four seasons in which we have sought such places in Narragansett Bay, they have been found. The year 1902 was an exception, and no very large sets were found, although the shores were carefully examined. The best time for collecting such seed is from the middle of July to the first of September. If the spat collectors, so successful in the small experiments, succeed on a large scale, an unlimited supply of seed can be secured in this way.

It is, of course, by no means unprofitable to plant clams of larger size, if the smaller ones cannot be obtained.

Methods of Caring for Seed Clams.—From the time the clams are dug until they are planted again they are best kept out of water, in thin layers to allow ventilation, and they should not, of course, be exposed to the sun. If they are small, they should not be allowed to become too dry, for it is not only actually injurious, but the much dried specimens will float away on the surface of the water. They can be kept well in moist sea weed.

At first thought it would seem to be better to keep them in fresh seawater, if possible in cars, but experiments show that the clams kept in this way burrow far less rapidly. Above all it is important to plant the clams as soon as possible after they have been dug; if they are kept, even for a day or two, they begin to lose, very noticeably, their power of burrowing.

Soil.—Clams will live and thrive in nearly every kind of soil; sticky mud and shifting sand, of course, must be avoided. In stony ground the shells are apt to become badly contorted, and even in gravelly soil the shells usually grow heavy and are marred by numerous so-called growth rings. These rings are produced by the wearing off of the thin edge of the shell; and in gravel, especially, if the clams are from time to time disturbed, this often occurs. Similar rings have been repeatedly produced artificially by running a file over the edge of the shell and then planting the clam; and the same principle applies to the notched clams described on page 54.

Method of Planting.—At this point there are many things which must be taken into consideration; the size and condition of the clams, the kind of soil, the time of day, time of tide, etc. The main point in planting is to get the largest possible proportion of the clams well installed in their burrows, with heads down and in firm soil. The method of sowing clams on the surface has been tried with a good degree of success, especially in the case of small clams measuring up to an inch, more or less, in length. Experiments tabulated on pages 47 and 64 represent very well the usual result of the sowing method. It will be seen by consulting this table that much depends upon the condition of the soil and upon the condition of the clams. The method has two distinct advantages; first, it is very rapid, and, second, when the clams have burrowed, they are in their proper position.

The advisability of loosening the soil before sowing is in some cases, perhaps, doubtful. Certainly the clams burrow more rapidly; but on the other hand some soils are made rather soft and watery when they are dug over and require considerable time to become firm again. In such cases the clams are more easily reached by predaceous crabs and eels, and washed out by the waves.

Temperature.—In cold weather the clams, like many other cold blooded animals, are torpid, and they burrow more slowly than usual, and sometimes not at all. Of a bushel of small clams, three-quarters of an inch in length, which were sowed on a cold day about the first of November, 1903, only very few burrowed during the first hour, most of them remaining on top of the ground until nearly noon the next day, when, as the weather became warmer, they began to burrow.

Time of Day and Time of Tide.—Clams sown with the rising tide have the advantage of an immediate chance to burrow, whereas those sown on the bare ground rarely succeed in burrowing until the tide has risen and covered them. It is not advisable to plant clams in the late afternoon, because, with the approach of darkness, the eels, crabs, and other enemies come in shore. We have often sowed them in the water over the beds with good results.

Tabulated Results of Experiments Upon the Rate of Burrowing Under Different Conditions.—The tables which are here republished are arranged from careful experiments made in the summer of 1900, and subsequent practice in planting has given them general substantiation.

The clams selected for these experiments were separated into four classes which are given successively in the tables, viz.:

I. Large, 50-70mm. (2–2¾ inches) in length;
II. Medium, 35-50mm.;
III. Small, 25-35mm.;
} Set of 1899 or previous to that date.
IV. Small set of 1900, 20-30mm.

To insure the protection of the clams while exposed, and to prevent them from washing away, boxes with 8-inch sides and ½-inch wire mesh bottoms were inverted over the beds. All the clams were sowed on the surface just as the tide was beginning to rise.

The attempt was made to determine the value of the following conditions for each class of clams:

a. Sowing clams immediately after digging.
b. “ “ kept 24 hours out of water (dry).
c. “ “ “ 24 “ in sea-water.
d. “ “ in soil softened by previous digging.
e. “ “ “ not dug up.
f. “ “ in gravel.
g. “ “ in sand.

For convenience in referring to the tables, these letters are placed in the first column.

An examination of the experiments here tabulated shows some interesting results which may be stated briefly as follows:

Of the three classes of clams which were more than one year old the smaller specimens were most successful in burrowing, the middle ones next, and the largest clams least successful. The fourth class composed of specimens a few months old were slightly less successful than the third.

Of the I (50-70mm. 2–2¾ inches) class, under all conditions	70	per cent.	burrowed.
II (35–50mm. 1⅜–2 inches)	85	per cent.	"
III (25–35mm. 1–1⅜ inches)	90.5	per cent.	"
IV (20–30mm. ¾–1⅜ inches)	87.7	per cent.	"

The effects of the varying conditions may be stated as follows:

(*a*) Planted immediately after digging (1 hour or less):

Class I	72	per cent.	burrowed.
" II	96	per cent.	"
" III	100	per cent.	"
" IV	97	per cent.	"

Average per cent. = 91.2

(*b*) Dry 24 hours.

Class I	68	per cent.	burrowed.
" II	78.6	per cent.	"
" III	97.3	per cent.	"
" IV	96	per cent.	"

Average per cent. =84.9

(*c*) Kept in water 24 hours between digging and sowing.

Class I	70.6	per cent.	burrowed.
" II	84.0	per cent.	"
" III	73.3	per cent.	"
" IV	73.3	per cent.	"

Average per cent. = 76.3

(*d*) Soil dug up before sowing.

Class I	82.6	per cent.	burrowed.
" II	94.6	per cent.	"
" III	97.3	per cent.	"
" IV	92	per cent.	"

Average per cent. = 91.6

(*e*) Soil not dug up before sowing.

Class I	62.4	per cent.	burrowed.
" II	79.2	per cent.	"
" III	86.4	per cent.	"
" IV	85.2	per cent.	"

Average per cent. = 78.3

(*f*) Sand.

Class I	70.6 per cent.	burrowed.
" II	88 per cent.	"
" III	92 per cent.	"
" IV	88.6 per cent.	"

Average per cent. = 84.8

(*g*) Gravel.

Class I	68 per cent.	burrowed.
" II	76 per cent.	"
" III	86 per cent.	"
" IV	84.5 per cent.	"

Average per cent. = 78.7

Summary: The average per cent. of all clams.............. 83.4 burrowed.

The average per cent. of those planted immediately after digging...... 91.2
" " of those dry 24 hours after digging............ 84.9
" " of those in water 24 hours after digging........ 76.3
" " of those in soil dug up before sowing........... 91.6
" " of those in soil not dug up before sowing...... 78.3

The details of these experiments are tabulated in the succeeding pages:

Class I.	Date.	Hour.	Number sowed.	Year of set.	Length in mm.	Time out of soil	How kept.	Soil.	Soil dug up?	Date of examination.	Hour of examination.	Time between sowing and examination.	Number exposed.	Per cent. burrowed.
a. d.	Sept. 13	4-5 P.M.	25	1898?	50-70	abt. 1 hour	dry	sand	yes	Sept. 14	8-9 A.M	16 hours	11	(56)
										Sept. 14	5 P.M.	24 hours	8	68
a. e.	Sept. 13	4-5 P.M.	25	1899?	50-70	1 hour	dry	sand	no	Sept. 14	8-9 A.M.	16 hours	9	(64)
										Sept. 14	5 P.M.	24 hours	6	76
b. d.	Sept. 13	4-5 P.M.	25	1899?	50-70	24 hours	dry	sand	yes	Sept. 14	8-9 A.M.	16 hours	8	(68)
										Sept. 14	5 P.M.	24 hours	2	92
b. e.	Sept. 13	4-5 P.M.	25	1899?	50-70	24 hours	dry	sand	no	Sept. 14	8-9 A.M.	16 hours	18	(28)
										Sept. 14	5 P.M.	24 hours	13	48
c. d.	Sept. 13	4-5 P.M.	25	1899?	50-70	24 hours	water	sand	yes	Sept. 14	8-9 A.M.	16 hours	8	(68)
										Sept. 14	5 P.M.	24 hours	3	88
c. e.	Sept. 13	4-5 P.M.	25	1899?	50-70	24 hours	water	sand	no	Sept. 14	8-9 A.M.	16 hours	16	(36)
										Sept. 14	5 P.M.	24 hours	12	52
b. e.	Sept. 15	6-6.30 P.M.	25	1899?	50-70	24 hours	dry	gravel	no	Sept. 16	9.30 A.M.	15 hours	13	(48)
										Sept. 17	8 A.M.	40 hours	9	64
c. e.	Sept. 15	6-6.30 P.M.	25	1899?	50-70	24 hours	water	gravel	no	Sept. 16	9.30 A.M.	15 hours	17	(32)
										Sept. 17	8 A.M.	40 hours	7	72
											Average percentage		=	70

CLASS II.	Date.	Hour.	Number sowed.	Year of set.	Length in mm.	Time out of soil.	How kept.	Soil.	Soil dug up?	Date of examination.	Hour of examination.	Time between sowing and examination.	Number exposed.	Per cent. burrowed.
a. d.	Sept. 13	4-5 P.M.	25	1899?	35-50	1 hour ±	dry	sand	yes	Sept. 14	8-9 A.M.	16 hours	4	(84)
										Sept. 14	5 P.M.	24 hours	2	92
a. e.	Sept. 13	4-5 P.M.	25	1899?	35-50	1 hour ±	dry	sand	no	Sept. 14	8-9 A.M.	16 hours	4	(84)
										Sept. 14	5 P.M.	24 hours	0	100
b. d.	Sept. 13	4-5 P.M.	25	1899?	35-50	24 hours	dry	sand	yes	Sept. 14	8-9 A.M.	16 hours	3	(88)
										Sept. 14	5 P.M.	24 hours	1	96
b. e.	Sept. 13	4-5 P.M.	25	1899?	35-50	24 hours	dry	sand	no	Sept. 14	8-9 A.M.	16 hours	13	(48)
										Sept. 14	5 P.M.	24 hours	10	60
c. d.	Sept. 13	4-5 P.M.	25	1899?	35-50	24 hours	water	sand	yes	Sept. 14	8-9 A.M.	16 hours	4	(84)
										Sept. 14	5 P.M.	24 hours	1	96
c. e.	Sept. 13	4-5 P.M.	25	1899?	35-50	24 hours	water	sand	no	Sept. 14	8-9 A.M.	16 hours	7	(72)
										Sept. 14	5 P.M.	24 hours	4	84
b. e.	Sept. 15	6-6.30 P.M.	25	1899?	35-50	24 hours	dry	gravel	no	Sept. 16	9.30 A.M.	15 hours	10	(60)
										Sept. 17	8 A.M.	40 hours	5	80
c. e.	Sept. 15	6-6.30 P.M.	25	1899?	35-50	24 hours	water	gravel	no	Sept. 16	9.30 A.M.	15 hours	12	(52)
										Sept. 17	8 A.M.	40 hours	7	72
											Average percentage		=	86¼

CLASS III.	Date.	Hour.	Number sowed.	Year of set.	Length in mm.	Time out of soil.	How kept.	Soil.	Soil dug up?	Date of examination.	Hour of examination.	Time between sowing and examination.	Number exposed.	Per cent. burrowed.
a. d.	Sept. 13	4-5 P.M.	25	1899	25-35	1 hour or less	dry	sand	yes	Sept. 14	8-9 A.M.	16 hours	1	(96)
										Sept. 14	5 P.M.	24 hours	0	100
a. e.	Sept. 13	4-5 P.M.	25	1899	25-35	1 hour or less	dry	sand	no	Sept. 14	8-9 A.M.	16 hours	1	(96)
										Sept. 14	5 P.M.	24 hours	0	100
b. d.	Sept. 13	4-5 P.M.	25	1899	25-35	24 hours	dry	sand	yes	Sept. 14	8-9 A.M.	16 hours	1	(96)
										Sept. 14	5 P.M.	24 hours	0	100
b. e.	Sept. 13	4-5 P.M.	25	1899	25-35	24 hours	dry	sand	no	Sept. 14	8-9 A.M.	16 hours	4	(84)
										Sept. 14	5 P.M.	24 hours	2	92
c. d.	Sept. 13	4-5 P.M.	25	1899	25-35	24 hours	water	sand	yes	Sept. 14	8-9 A.M.	16 hours	6	(76)
										Sept. 14	5 P.M.	24 hours	2	92
c. e.	Sept. 13	4-5 P.M.	25	1899	25-35	24 hours	water	sand	no	Sept. 14	8-9 A.M.	16 hours	14	(44)
										Sept. 14	5 P.M.	24 hours	8	68
b. e.	Sept. 15	6-6.30 P.M.	25	1899	25-35	24 hours	dry	gravel	no	Sept. 16	9.30 A.M.	15 hours	5	(80)
										Sept. 17	8 A.M.	40 hours	0	100
c. e.	Sept. 15	6-6.30 A.M.	25	1899	25-35	24 hours	water	gravel	no	Sept. 16	9.30 A.M.	15 hours	13	(48)
										Sept. 17	8 A.M.	40 hours	7	72
											Average percentage		=	90½

CLASS IV.	Date.	Hour.	Number sowed.	Year of set.	Length in mm.	Time out of soil.	How kept.	Soil.	Soil dug up?	Date of examination.	Hour of examination.	Time between sowing and examination.	Number exposed.	Per cent. burrowed.
a. d.	Sept. 13	4-5 P.M.	50	1900	20-30	1 hour or less	dry	sand	yes	Sept. 14	8-9 A.M.	16 hours	4	(92)
										Sept. 14	5 P.M.	24 hours	3	94
a. e.	Sept. 13	4-5 P.M.	50	1900	20-30	1 hour or less	dry	sand	no	Sept. 14	8-9 A.M.	16 hours	2	(96)
										Sept. 14	5 P.M.	24 hours	0	100
b. d.	Sept. 13	4-5 P.M.	50	1900	20-30	24 hours	dry	sand	yes	Sept. 14	8-9 A.M.	16 hours	9	(82)
										Sept. 14	5 P.M.	24 hours	3	94
b. e.	Sept. 13	4-5 P.M.	50	1900	20-30	24 hours	dry	sand	no	Sept. 14	8-9 A.M.	16 hours	8	(84)
										Sept. 14	5 P.M.	24 hours	2	96
c. d.	Sept. 13	4-5 P.M.	50	1900	20-30	24 hours	water	sand	yes	Sept. 14	8-9 A.M.	16 hours	9	(82)
										Sept. 14	5 P.M.	24 hours	6	88
c. e.	Sept. 13	4-5 P.M.	50	1900	20-30	24 hours	water	sand	no	Sept. 14	8-9 A.M.	16 hours	21	(56)
										Sept. 14	5 P.M.	24 hours	20	60
b. e.	Sept. 15	6-6.30 P.M.	50	1900	20-30	24 hours	dry	gravel	no	Sept. 16	9.30 A.M.	15 hours	3	(94)
										Sept. 17	8 A.M.	40 hours	1	98
c. e.	Sept. 15	6-6.30 P.M.	50	1900	20-30	24 hours	water	gravel	no	Sept. 16	9.30 A.M.	15 hours	23	(54)
										Sept. 17	8 A.M.	40 hours	14	72
											Average percentage		=	87¾

When clams are planted and covered with soil, instead of being sowed on the surface, they should, if possible, be placed in the natural position, head down; otherwise they find difficulty in adjusting themselves, and often even work their way to the surface and burrow again. They should not be planted too deep, for with a considerable depth of soil over them they are apt to smother before they can adjust themselves and reach the surface with their siphons.

An experiment was made in 1902 with three hundred selected clams, one and one-quarter inches in length, for the purpose of demonstrating the effect of planting in different positions and in various depths of soil; and although the experiment was on a small scale, the results indicated clearly the advantage of planting in normal position and not too deep.

Depth as a Factor in Planting.—Results Four Days After.

Depth of Planting.	Method of Planting.	Number Planted.	Number Alive.	Number Dead.	Number Missing.	Range in Depth.	Average Depth.
Just covered over.......	Inverted.....	25	22	3	None.	1″-3″	2″
	Buried flat............	25	24	1	None.	1″-3″	2″
	Normal position......	25	25	0	None.	½-1″-4″	2½″
Six inches...............	Inverted.............	25	17	8	None.	4″-6″-7″	6″
	Buried flat	25	19	6	None.	3″-5″-7″	5½″
	Normal position......	25	23	2	None.	1″-3″-5″	4″
Twelve inches....	Inverted.............	50	10	37	3	10″-5″-4″	7″
	Buried flat.......... .	50	21	29	None.	5″-6″-9″	8″
	Normal position......	50	33	17	None.	1″-4″-8″	6″

The ideal method of planting in case of the larger clams, one and one-half inches long and upwards, is to place the clam head down in a hole made in the firm soil and to cover with an inch or two of loose soil. This, of course, is a rather tedious method for use on a large scale, and yet, if narrow furrows are cut in the ground, a large quantity can be planted in a few hours.

THE RATE OF GROWTH AND AGE AT MATURITY.

In a consideration of clam culture, of the propagation of clams on public shores, or of restrictive legislation, it is of importance to know the rate of growth of the clam, and the age at which it may reasonably be expected to reach a marketable size. This was one of the first questions which the commission undertook to solve; for in regard to it, even among professional clam diggers, there existed a wide difference of opinion. The problem turned out to be less simple than it might seem at first, mainly from the fact, which was soon learned, that the rate of growth varies extremely according to different conditions.

The main spawning season is about June, and the clams ordinarily reach sexual maturity and begin to spawn in one year. They become a marketable size, that is about three inches in length, in from eighteen months to two years, if they are given fairly favorable conditions. In Narragansett Bay, however, they are not intentionally allowed to reach this size, but are dug and sent to market or to the clambakes as soon as they are a year old, and often before. At some of the popular clambakes great quantities of clams are daily served which are not as large as some specimens which we know to be less than four months old.

Methods of Determining the Rate of Growth.—To ascertain the rate of growth, various methods have been employed. Individual specimens have been isolated in flower pots and land tiles which were set into the ground; enclosures of various sorts have been planted with clams, all of approximately the same size; the set of a particular season has been kept under constant observation without transplanting; and large areas of ground, half an acre or more in extent, have been planted in various places.

During the last year a new and excellent method of indelibly marking the shell was devised, which serves as a record of the growth of individual clams wherever they are planted. The so-called rings of growth, usually present on the shell, are not by any means a reliable way of determining the age of the specimen. These rings are due to the rubbing and breaking of the fine edge of the shell from any cause whatever; they are liable to be repeated at any time within a few months, and, on the other hand, they may not appear at all, even in clams which are much more than a year old.*

Distinct rings are always produced when a clam is taken and allowed to burrow again in coarse sand or gravel. We have often produced the ring in this way and also by wearing off the edge of the shell by running a file over it. It was this observation, indeed, which suggested the following simple method of indelibly marking the clams. A small notch is filed into the edge of the shell and the clam returned to the soil. As it grows the notch remains perfectly distinct and always at the original distance from the hinge. When the clam is again examined the notch identifies it as the one which was planted, and furthermore indicates the amount of growth. A growth ring usually accompanies the notch, and so, after a month, or even years, the complete outline of the clam at the time of notching can be readily identified and traced upon the shell of larger growth. The device allows greater freedom in distributing experimental seed clams, and provides, at the same time, perfect accuracy in the results. Figs. 8, 9, 10, and 11.

Experiment Upon Rate of Growth.—The following brief account of some experiments and observations, made during the past few years, gives numerous examples of the sizes of clams at different ages, and illustrates also the variability in the rate of growth. As far as possible the general statements and the statistical tables will be given separately.

Experiment No. 1. An exceedingly thick set of clams, discovered in July, 1899, on the southernmost point of Cornelius Island,

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* Fig. 12 illustrates this point. It is from a life-size photograph of a clam one year and three months old, three inches in length, which, from July 18, 1901, to September 10 of the following year, lay buried in a land tile which was set perpendicularly in the ground. This specimen was not disturbed during this time, and no growth rings are visible on the shell.

Wickford, was kept under observation throughout the summer. On the 9th of August, after they had become considerably thinned by the crowding out process, 12,500 specimens were gathered from one square yard by means of a rather coarse sieve. A large number of smaller specimens were probably lost through the meshes of the sieve. On various dates the average size was calculated from a considerable number of specimens. When first observed, on July 4th, the average length was 6.1mm. (¼ of an inch); a month later, on August 4th, they had more than doubled this length and measured 13.9mm. (½ + inches); on September 30th, the average length was 23.7mm. (⅞ inches); they were then about three months old.

Experiment No. 2. On July 6th and 9th of the same year, clams to the total amount of a pint and a half (about 2,000 specimens) were taken from the above set and sown on the surface of a box of sand and distributed as evenly as possible; the box was kept suspended about 18 inches below the surface of the water at the houseboat. These clams were continuously submerged during the months of July and September, and during August were exposed at low tide occasionally, when the houseboat was ashore. They grew very much faster than those which remained on the shore. For example, on August 4th they averaged 21.8mm. (13-16 inches) in length against 13.9mm. (½ inch) on the shore; and on September 30th 29mm. (1⅛ fnches) against 23.7mm. (⅞ inches) on the shore. The difference was due to the more favorable location of the transplanted clams; they were entirely unmolested and were continuously under water in the tidal current, which was full of food, and they lay night and day with the siphons expanded at the surface of the ground. The two accompanying curves represent the difference in the rate of growth between these two classes of clams.

Experiment No. 3. Several specimens were taken from this same set on July 19th, 1899, individually measured, and kept separate in flower pots placed under water at the houseboat. These specimens measured from 8 to 12mm. (5-16—7-16 inches). About seven weeks later, on September 10th, they were again measured, were found to have more than doubled their length, and in some instances to have trebled it.

Experiment No. 4. On July 22, 1899, a number of clams from the same shore were planted separately in land tiles set perpendicularly in the ground, and arranged in rows, from extreme low-water mark to high water mark, at intervals of about two feet. A part of those in one row were measured again about two months later, on September 18th; they showed a decided difference in the rate of growth, those planted at low tide having grown very much more rapidly than those higher up. In the lowest tiles (except the first, which was empty) they measured respectively 48, 46, and 44mm. ($1\frac{7}{8}$, $1\frac{13}{16}$, $1\frac{11}{16}$ inches) in length—nearly two inches for clams about three months old.

The more rapid growth of clams lying near low-water mark as compared with those higher up on the shore, so well illustrated here, has often been observed in other instances, and is evidently due to the fact that those at low water have a much longer time each day in which to feed.

Experiment No. 5. On August 14, 1900, about 1,300 small clams were taken from an artificial spat collector and transplanted in sand boxes suspended about one foot beneath the surface of the water at the houseboat. About the first of October they were transferred to new boxes on the shore, where they have remained since that time. At the houseboat they grew remarkably fast, but since they have been on the shore the growth has not been above the average. On August 14, the date of transferring to the houseboat, they averaged about 12mm. ($\frac{1}{2}$ an inch) in length and, on September 20, they had grown to three times this length and averaged 36mm. ($1\frac{1}{2}$ inches).

This case furnished a beautiful example of the extreme variations in growth, inasmuch as the clams which were left in the spat collector were also measured on September 30 and had increased by only half their length, that is 5mm. ($\frac{1}{5}$ of an inch). Compare Figure No. 3, Plate No. 2, report for 1900.

At the end of the first year the transplanted specimens averaged about 50 mm. (2 inches), at the end of the second year 74mm. (3 inches) and, when three years and four months old, 80mm. (3⅛ inches). The growth in the third year was probably rather slower than that of average clams under favorable conditions, for the conditions were, in this case, not particularly favorable.

The plotted curve, diagram II, represents the average size of these specimens during three and one-half years. Fig. 13 is from a life size photograph of the average specimens taken at intervals during this time.

Experiment No. 6. More than 20 bushels of very small clams, averaging about 10,000 to the quart, were taken from the shore of Green's Island in the summer of 1901 and transplanted in several of the commission beds at various places. The growth of these transplanted clams, and of those which remained at Green's Island, was observed from time to time.

At the end of six months sample specimens were taken from Buttonwoods and from Rumstick. They exhibited a very noticeable difference in their growth, those from Rumstick averaging 37.5mm. (1½ inches), while those at Buttonwoods averaged 50.2mm., a trifle over 2 inches.

In January, 1903, when the clams were about a year and a half old, those transplanted at Cornelius Island, Wickford, averaged 58.5mm. (2 5-16 inches); those at Mill Cove, Wickford, 63.mm. (2 7-16 inches); those at Kickemuit River, 68.1mm. (2⅝ inches); and those left at Green's Island, 57.4mm. (2¼ inches).

When examined in the latter part of 1903, when the clams were two and a third years old, those at Mill Cove averaged 85.3mm. (3⅜ inches), those at Kickemuit River, 91mm. (3⅝ inches); and those which remained at Green's Island, 76mm. (3 inches).

The average length of these clams in all the experiments was for the first half year 41.8mm. (1⅝ inches); for the first year and a half, 61.7mm. (2 7-16 inches); and for two and a third years, 84mm. (3⅜ inches).

Experiment No. 7. The question is often raised—what is the effect of close planting or overcrowding on the rate of growth? We are, as yet, not prepared to give a final answer, for the evidence from different observations has been more or less contradictory. The clams planted in the sand boxes at the houseboat, described under experiment No. 2, grew very rapidly, though they were so close together that their shells almost touched. On the other hand, the following experiment showed a very distinct dwarfing effect from overcrowding.

In September, 1902, a pint and a half of very small clams which remained over from another experiment were poured upon the ground and covered with a circular sieve to keep them from becoming scattered. The clams were spread as evenly as possible, but were so thick that they touched one another, and in some places were piled two or three deep. Just beside this place other clams of the same size were planted about two inches apart and covered with wire screening. The next day all of the clams, with the exception of a few crushed ones, had burrowed, and, after the sieve was taken up, the circular area was plainly defined by the abundance of clam holes. The clams were, from this time, protected by wire screening and left undisturbed for about one year. When the netting was removed and the place examined again, in October, 1903, the outline of the original area of thickly planted clams could still be traced readily, on account of the numerous holes, although it had become somewhat uneven. The clams were small and stubby, and the shells were thick and deeply scarred. Although they were now about a year and four months old, they were not as large as the average clams of six months.

The control specimens, which were planted near them and given plenty of room, showed at this time a good average growth. In Fig. 14 are shown samples of both kinds.

Experiment No. 8. In this experiment we made use of the device mentioned on page 54, of recording the growth by notching the shell. Clams were selected from various localities of different sizes and ages. After each specimen was carefully notched, they were all planted at one time, on February 20, 1903, in the same locality, on the shore of Mill Cove, Wickford. The specimens were divided into three classes, according to their age and size, as follows:

1. Clams taken form Nayatt Point averaging 25mm. (1 inch), and undoubtedly of the set of 1902, age about seven months.

2. Clams taken from Green's Island, averaging 60mm. ($2\frac{1}{4}$ inches), undoubtedly of the set of 1901, age about one year and seven months.

3. Clams taken from the Kickemuit River at one of the low winter tides. The time of setting is unknown, but the clams showed, by their large size and thick shells, that they were of great age.

At various dates during the next summer samples of these clams (about 25 at a time) were taken up, measured, and preserved. The notch and its growth ring on each specimen prove an accurate record of the size of the clam at the beginning of the experiment. The average measurement of these samples from the 20th of February, 1903 (the beginning of the experiment), and on the dates next examined, together with the percentage in increase, is given below:

Date of Observation.	Set of 1902.			Set of 1901.			Very Old Clams.		
	mm.	inches	Percentage increase in length.	mm.	inches.	Percentage of increase.	mm.	inches.	Percentage of increase.
Feb. 20.........	25	1	......	59.00	$2\frac{5}{16}$	......	106.0	$4\frac{1}{8}$	......
July 6.........	40	$1\frac{9}{16}$	60	65.00	$2\frac{9}{16}$	10	106.0	$4\frac{1}{8}$	0.0
Aug. 10.........	43	$1\frac{5}{8}$	72	68.00	$2\frac{10}{16}$	15	106.0	$4\frac{1}{8}$	0.0
Sept. 10.........	47	$1\frac{7}{8}$	88	70.00	$2\frac{3}{4}$	18	106.0	$4\frac{1}{8}$	0.0
Oct. 20..... ...	61	$2\frac{3}{8}$	144	71.80	$2\frac{13}{16}$	21	106.3	$4\frac{3}{16}$	0.3

The clams were further grouped, according to size, into six classes regardless of age, and the result of this classification is as follows:

AVERAGE MEASUREMENTS.

SELECTED SIZES.	JULY 6.			AUGUST 10.		
	Average original size.	Average size.		Average original size.	Average size.	
	mm.	*mm.*	*inches.*	*mm.*	*mm.*	*inches.*
Over 3 inches	76.0	78.6	$3\frac{1}{8}$	77.0	79.6	$3\frac{1}{8}$
Between $2\frac{1}{2}$ and 3 inches	66.0	70.2	$2\frac{13}{16}$	67.0	72.1	$2\frac{7}{8}$
Between 2 and $2\frac{1}{2}$ inches	54.0	60.0	$2\frac{3}{8}$	57.2	66.0	$2\frac{3}{8}$
Between $1\frac{1}{2}$ and 2 inches	45.0	58.0	$2\frac{5}{16}$	43.2	60.8	$2\frac{3}{8}$
Between 1 and $1\frac{1}{2}$ inches	30.2	47.2	$1\frac{7}{8}$	29.4	48.5	$1\frac{7}{8}$
Between $\frac{1}{2}$ and 1 inch	21.1	35.0	$1\frac{3}{8}$	21.2	37.2	$1\frac{1}{2}$

AVERAGE MEASUREMENTS.

SELECTED SIZES.	SEPTEMBER 10.			OCTOBER 20.		
	Average original size.	Average size.		Average original size.	Average size.	
	mm.	*mm.*	*inches.*	*mm.*	*mm.*	*inches.*
Over 3 inches	79.0	82.0	$3\frac{1}{4}$	77.0	82.0	$3\frac{1}{4}$
Between $2\frac{1}{2}$ and 3 inches	66.8	73·9	$2\frac{15}{16}$	68.7	76.5	$3\frac{1}{8}$
Between 2 and $2\frac{1}{2}$ inches	53.8	65.0	$2\frac{9}{16}$	53.2	70.6	$2\frac{13}{16}$
Between $1\frac{1}{2}$ and 2 inches	47.7	63.6	$2\frac{1}{2}$	46.6	69.0	$2\frac{3}{4}$
Between 1 and $1\frac{1}{2}$ inches	28.1	56.0	$2\frac{1}{4}$	28.0	64.8	$2\frac{9}{16}$
Between $\frac{1}{2}$ and 1 inch	21.8	47.0	$1\frac{7}{8}$	21.8	59.3	$2\frac{3}{8}$

Statistical Statements of the Age and Size according to Experiments and Observations on the rate of Growth of Clams up to the beginning of the year 1904.

Experiment Number.	Age.	Length.		Time under observation.	Percentage of increase in length while under observation.	Percentage of increase in length per week since the last previous observation.	
		mm.	Inches.			Number of weeks since the previous observation.	Weekly Percentage.
No. 1.	4 weeks.	6.1	$\frac{1}{4}$	....	....	......	....
	6 “	9.5	$\frac{3}{8}$	10 days.	$55\frac{3}{4}$ pr. ct.	1.4	$36\frac{3}{4}$ pr. ct.
	7 “	9.9	$\frac{3}{8}$	17 “	62 “	1.0	$4\frac{1}{5}$ “
	9 “	13.9	$\frac{1}{2}$	31 “	127 “	2.0	$20\frac{1}{5}$ “
	$12\frac{1}{2}$ “	17.5	$\frac{5}{8}$	56 “	186 “	3.4	$7\frac{3}{7}$ “
	14 “	18.8	$\frac{11}{16}$	65 “	208 “	1.2	7 “
	17 “	23.7	$\frac{7}{8}$	88 “	278 “	3.2	$7\frac{3}{5}$ “
	27 “	27.7	$1\frac{1}{16}$	153 “	354 “	9.2	$1\frac{7}{10}$ “
No. 2.	4 “	6.1	$\frac{1}{4}$	....	....	......	....
	8 “	21.8	$1\frac{3}{16}$	28 days.	257 pr. ct.	4.0	64 pr. ct.
	12 “	23.2	$\frac{7}{8}$	53 “	280 “	3.5	$1\frac{1}{2}$ “
	14 “	25.6	1	63 “	319 “	1.4	5 “
	17 “	29.0	$1\frac{1}{8}$	85 “	377 “	3.1	6 “
No. 5.	2 mos.	12.1	$\frac{7}{16}$	....	....	......	....
	3 “	16.9	$\frac{5}{8}$	$3\frac{1}{2}$ weeks.	23 pr. ct.	3.5	$6\frac{4}{7}$ pr. ct.
	$3\frac{1}{2}$ “	36.0	$1\frac{7}{16}$	$5\frac{1}{4}$ “	197 “	1.75	$30\frac{1}{3}$ “
	$4\frac{1}{4}$ “	40.0	$1\frac{9}{16}$	9 “	230 “	3.75	0.5 “
	1 yr. 2 “	50.0	2	1 yr. 7 days.	313 “	43.0	0.5 “
	1 “ 7 “	68.0	$2\frac{11}{16}$	1 “ $5\frac{1}{4}$ mos.	462 “	21.0	1.7 “
	2 “ 2 “	74.0	$2\frac{15}{16}$	2 “	511 “	29.0	0.3 “
	3 “ 4 “	80.0	$3\frac{1}{8}$	3 “ 2 mos.	561 “	60.0	0.1 “
No. 6.	2 “	9.5	$\frac{3}{8}$	....	....	......	....
	7 “	50.2	2	5 mos. 8 days	427 pr. ct.	22.0	19.4 pr. ct.
	7 “	37.5	$1\frac{1}{2}$	5 “ “	294 “	22.0	16.1 “
	1 yr. 7 “	57.4	$2\frac{1}{4}$	1 yr. 5 mos.	504 “	73.0	6.9 “
	1 “ 7 “	58.5	$2\frac{5}{16}$	1 “ 5 “	515 “	73.0	7. “
	1 “ 7 “	63.0	$2\frac{7}{16}$	1 “ 5 “	563 “	73.0	7.7 “
	1 “ 7 “	68.0	$2\frac{5}{8}$	1 “ 5 “	610 “	73.0	8.3 “
	2 “ 6 “	76.0	3	2 yrs. 4 “	700 “	47.0	0.7 “
	2 “ 4 “	85.3	$3\frac{3}{8}$	2 “ 2 “	798 “	39.0	0.8 “
	2 “ 4 “	91.0	$3\frac{5}{8}$	2 “ 2 “	858 “	39.0	0.8 “
	7 “	25.0	1	....	....	......	....
	1 “	40.0	$1\frac{9}{16}$	$4\frac{1}{2}$ mos.	65 pr. ct.	20.0	3.2 pr. ct.
	1 “ 1 mo.	43.0	$1\frac{11}{16}$	$5\frac{1}{2}$ “	70 “	4.5	1.6 “
	1 “ 2 “	47.5	$1\frac{3}{4}$	$6\frac{1}{2}$ “	109 “	4.5	2.3 “
	1 “ 3 “	65.2	$2\frac{9}{16}$	$7\frac{1}{2}$ “	150 “	4.5	3.9 “
	1 “ 7 “	60.16	$2\frac{3}{8}$	....	....	......	....
	2 “	66.01	$2\frac{9}{16}$	$4\frac{1}{2}$ mos.	10 “	20.0	.5 pr. ct.
	2 “ 1 mo.	68.0	$2\frac{5}{8}$	$5\frac{1}{2}$ “	15 “	4.5	.7 “
	2 “ 2 “	69.5	$2\frac{3}{4}$	$6\frac{1}{2}$ “	17 “	4.5	.4 “
	2 “ 3 “	71.6	$2\frac{3}{4}$	$7\frac{1}{2}$ “	20 “	4.5	.6 “
	1 “ 7 “	60.0	$2\frac{3}{8}$	1 yr. 5 “	533 “	73.0	7.3 “

Statistical Statements of the Age and Size according to Experiments and Observations on the rate of Growth of Clams up to the beginning of the year 1904.

Experiment Number.	Age.	Length.		Time under observation.	Percentage of increase in length while under observation.	Percentage of increase in length per week since the last previous observation.	
		mm.	Inches.			Number of weeks since the previous observation.	Weekly Percentage.
No. 6.	1 yr. 7 mos.	62.0	$2\frac{1}{2}$	1 yr. 5 mos.	554 pr. ct.	73.0	7.6 pr. ct.
	1 " 7 "	64.0	$2\frac{9}{16}$	1 " 5 "	575 "	73.0	7.8 "
	1 " 7 "	62.0	$2\frac{1}{2}$	1 " 5 "	554 "	73.0	7.6 "
	1 " 7 "	68.1	$2\frac{3}{4}$	1 " 5 "	624 "	73.0	8.5 "
	1 " 7 "	59.5	$2\frac{3}{8}$	1 " 5 "	533 "	73.0	7.3 "
	1 " 7 "	62.5	$2\frac{1}{2}$	1 " 5 "	554 "	73.0	7.6 "
	1 " 7 "	63.0	$2\frac{1}{2}$	1 " 5 "	570 "	73.0	7.7 "

RESULTS OF EXPERIMENTS IN TRANSPLANTING.

The experiments we have just been discussing have demonstrated that clams of any age and size can be transplanted successfully, and that the rate of growth under favorable conditions justifies the expectation of a crop in about two years from the date of spawning. We have been able, also, to test the feasibility of transplanting by experiments on a comparatively large scale.

In accordance with the act passed by the General Assembly, at its January session, in the year 1901, the commission was enabled to occupy and have the exclusive right in certain areas of shore, between high and low water, set aside for experimental purposes (see Appendix). Taking advantage of this opportunity, experiments were made in transplanting the clams found in such phenomenal abundance at Green's Island in the summer of 1901.

The clams were taken when they were very small and transplanted to different localities in different parts of the Bay on the reservation beds. The data in respect to the planting, and the results of the experiments as shown by examination of the beds in January, 1903, a year and a half after planting, are tabulated as follows:

Number.	Location.	Area.	Amount sowed.	Aver. No. per qt.	When sowed.	Condition of Tide.	Condition of wind.	Time between digging and sowing.	How kept.	Remarks.
1	*S. shore, Mill Cove* .... *a*	*50 x 25 ft.*	*36 qts.*	*2,135*	*Aug. 14, 11 a. m.*	*Just turning*..... *Low about 12.*	*None.*	*24 hours.*	*In water..*	*1-3 unplanted.*
	Very poor soil. At time of planting and for sometime before there were *no* clams in plot. Now a very few, not over 2 or 3 per square foot. None at all in the third unplanted.									
1	*b*	*50 x 25 ft.*	*54 qts.*	*2,135*	*Aug. 17. 5:30 p. m.*	*Coming in*....... *Low about 2:30.*	*None.*	*26 hours.*	*Dry*......	*Plot partly grass.*
	Three diggings gave an average of 17 per square foot. (1) Area 15 x 15 inches produced 16 clams. (2) Area 15 x 15 inches produced 28 clams. (3) Area 1 x 1 foot produced 21 clams. The average length 60 mm. (2⅜ inches).									
2	*S. shore, Cornelius Island*............. *a*	*50 x 25 ft.*	*36 qts.*	*2,135*	*Aug. 14, 1 p. m.*	*Coming in*....... *Low about 12.*	*None.*	*24 hours.*	*In water..*	*Loamy sand.*
	Upper half of bed gave 24 per square foot. Area 15 x 15 inches produced 37 clams. Lower half (miry sand) 7 to 8 per square foot. Average length 62 mm. (2½ inches).									
2	*b*	*50 x 25 ft.*	*54 qts.*	*2,135*	*Aug. 16, 5:30 p. m.*	*Half in* .... *Low about 1:40.*	*None.*	*26 hours.*	*In water..*	*Loamy sand.*
	Upper half produced 34 per square foot. Area 15 x 15 inches produced 51 clams. Lower half (miry sand) 9 to 11 per square foot. Average length 64 mm. (2 9-16) inches).									
3	*Rumstick*...............................	*150 x 50 ft.*	*72 qts.*	*9,700*	*Aug. 17, 3 p. m.*	*Coming in*....... *Low about 2:40.*	*Brisk.*	*2 hours.*	*Dry.*	*Fine gravel.*
	Only occasionally a clam.									
4	*Fishing Cove* (*Wickford*)............... *a*	*25 x 50 ft.*	*45 qts.*	*9,700*	*Aug. 18, 10 a. m.*	*High* .... *Low about 3:30.*	*Light.*	*20 hours.*	*Dry*.......	*Fine gravel.*
	Two diggings averaged 16 per square foot. (1) 15 x 15 inches produced 24 clams. (2) 15 x 15 " " 23 " Average length 62 mm. (2½ inches.)									

Number.	Location.	Area.	Amount sowed.	Aver. No. per qt.	When sowed.	Condition of Tide.	Condition of wind.	Time between digging and sowing.	How kept.	Remarks.
4	One digging gave 14 per square foot. 15 x 15 inches produced 21 clams.	*b 25 x 50 ft.*	*54 qts.*	*9,700*	*Aug. 24,* *5 p. m*	*Half out.........* *Low about 7:20.*	*Light.*	[illegible]	*Dry......*	[illegible]
5	*Kickemuit River.......................*	*a 60 x 150 ft.*	*108 qts.*	*9,700*	*Aug. 19,* *2 p. m.*	*Going out........* *Low about 4:10.*	*Light.*	*4 1-2 hours*	*Dry....*	*Sandy loam.*
	One digging in a place with average number of holes gave 34 per square foot. 15 x 15 inches produced 127 clams or 3 quarts. (Some of them of more recent set.)									
5		*b 60 x 150 ft.*	*108 qts.*	*9,700*	*Sept. 7,* [illegible]	*Low. ....* [illegible]	*None.*	[illegible]	*Dry.....*	*Sandy loam.*
	One digging gave 90 per square foot 15 x 15 inches produced 138 clams or 4 quarts. (Some of more recent set.) Average length 68 mm. (2¾ inches).									
6	*Smith's Pasture, Mill Cove.........*	*200 x 60 ft.*	*1[illegible] qts.*	*9,700*	*Aug. [illegible]* *3 p. m.*	*Going out .....* *Low about 6.*	*Light.*	*4 hours.*	*Dry....*	[illegible]
	Two diggings gave average 23 clams per square foot. 18 x 18 inches produced 56 clams. 18 x 18 " " 51 " As on Cornelius (2 (a) and (b)) lower edge of bed clams very poor. Average length 59.5 mm. (2⅜ inches).									
7	*Duck Cove (Wickford)..................*	*100 x 50 ft.*	*45 qts.*	*9.700*	*Aug. 24,* *[illegible] p. m.*	*Going out........* *Low about [illegible].*	*Light.*	*4 hours*	*Dry....*	*Rocky beach.*
	Very few present. Average length 62.5 mm. (2½ inches).									
8	*South shore, Mill Cove..................*	*100 x 60 ft.*	*108 qts.*	*9,700*	*Aug. 26,* *5:30 p. m*	*High tide........* *Low about 10.*	*Light.*	[illegible]	*Dry....*	*Coarse gravel &*
	One digging produced 32 per square foot. 15 x 15 inches produced 46 clams. Average length 63 mm. (2½ inches)									

Number.	Location.	Area.	Amount sowed.	Aver. No. per qt.	When sowed.	Condition of Tide.	Condition of wind.	Time between digging and sowing.	How kept.	Remarks.
9	*Old Buttonwoods*	*150 x 60 ft.*	*99 qts.*	*9.700*	*Aug. 28, 1 p. m*	*Half in* *Low about 10.*	*Light.*	*3 hours.*	*Dry.*	*Shifting sand.*
	Showed excellent growth in January, 1901. Since then clams have disappeared: either many been dug or otherwise destroyed.									
10	*Rabbitt Island* (*Wickford*)	*100 x 50 ft.*	*54 qts.*	*9,700*	*Aug. 28, 4 p m.*	*Almost in* *Low about 11:40.*	*Light.*	*6 hours.*	*Dry.*	*Fine gravel and sand.*
	Produced a great quantity of clams. Bed was dug over many times before clams were 1 year old.									
11	*N. shore, Cornelius Island*	*200 x 20 ft.*	*45 qts.*	*9,700*	*Aug. 29, 5 p. m.*	*High* *Low about 12:30.*	*Light.*	*3 hours.*	*Dry.*	*Coarse gravel.*
	Poor locality; no results.									
12	*Quonset*	*60 x 60 ft.*	*36 qts.*	*9,700*	*Sept. 5, 10 a. m.*	*Half in* *In, 1:20.*	*Light.*	*20 hours.*	*Dry.*	*Sandy and shifting.*
	Produced good quantity. Thoroughly dug up.									
13	*Cold Spring,* (*Wickford*)	*60 x 60 ft.*	*40 qts.*	*9,700*	*Sept. 5. 11 a. m.*	*Coming in* *In, 1:20.*	*Light.*	*21 hours.*	*Dry.*	*Sandy gravel.*
	Evidence of some digging; no results.									

It will be seen by consulting the tables that, in the greater number of beds, the clams were thriving well and were promising an excellent crop at the end of 18 months. Nearly all of the experiments were spoiled, however, before the clams became two years old, by poachers. It is practically impossible to stand guard night and day over so many beds. The experiments, though they were interrupted, nevertheless show that it is feasible to raise clams by this method, also that the greatest difficulty is to provide protection until the crop can mature.

One of the experiments, that in the Kickemuit River, was carried to completion, and the clams were left practically undisturbed for two years.

We are glad to acknowledge our special obligation to the members of the firm of C. E. Brown & Sons, and to Mr. Charles Hull, through whose aid it was possible to complete, for the first time, an experiment in transplanting clams on a large scale in Narragansett Bay.

On July 20th, 17 bushels of clams were dug from a space about 300 square feet, by two men, at one tide, and they had finished digging within an hour after the tide had begun to rise.*

At this rate of production the yield would be more than 2,400 bushels per acre. From one square yard three pecks of clams were dug, corresponding to a yield of 3,600 bushels per acre.

The bed was opened to the public on August 10th, 1903, and shortly after midnight the diggers began to assemble and made use of the early morning tide, which was low at about two o'clock. At low tide in the afternoon, more than 50 persons were engaged in digging upon this bed. The ground was continually dug over throughout the rest of the summer, and even as late as November. On October 20, for example, there were eleven persons digging on this bed.

According to the estimate of those who have watched the yield from this bed most closely, about 600 to 700 bushels have been taken from it The bed is about 2/5 of an acre in extent. This estimate is low as compared with the proportionate yield of the sample areas already referred to.

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* Probably a considerable number of clams were overlooked in so rapid digging, which would, of course, raise the production from this area.

In some parts of the bed there were evidences that the clams were killed at an early age, perhaps by the decaying seaweed which was very abundant, and some dead specimens also were found near the entrance of a small fresh water stream.

A large set of young clams was found in this bed, and, in some sample areas, they numbered three hundred to the square yard. They were of different sizes and had, of course, set since the bed was sown in the summer of 1901.

This experiment affords the final proof of two fundamental propositions, viz., 1st, that it is feasible, practicable, and profitable to transplant clams, and that a good crop can be reared in two years; 2nd, that it is not necessary or profitable to dig up the shore and loosen the soil in order that clams may grow and thrive well, or in order that they may set thickly.

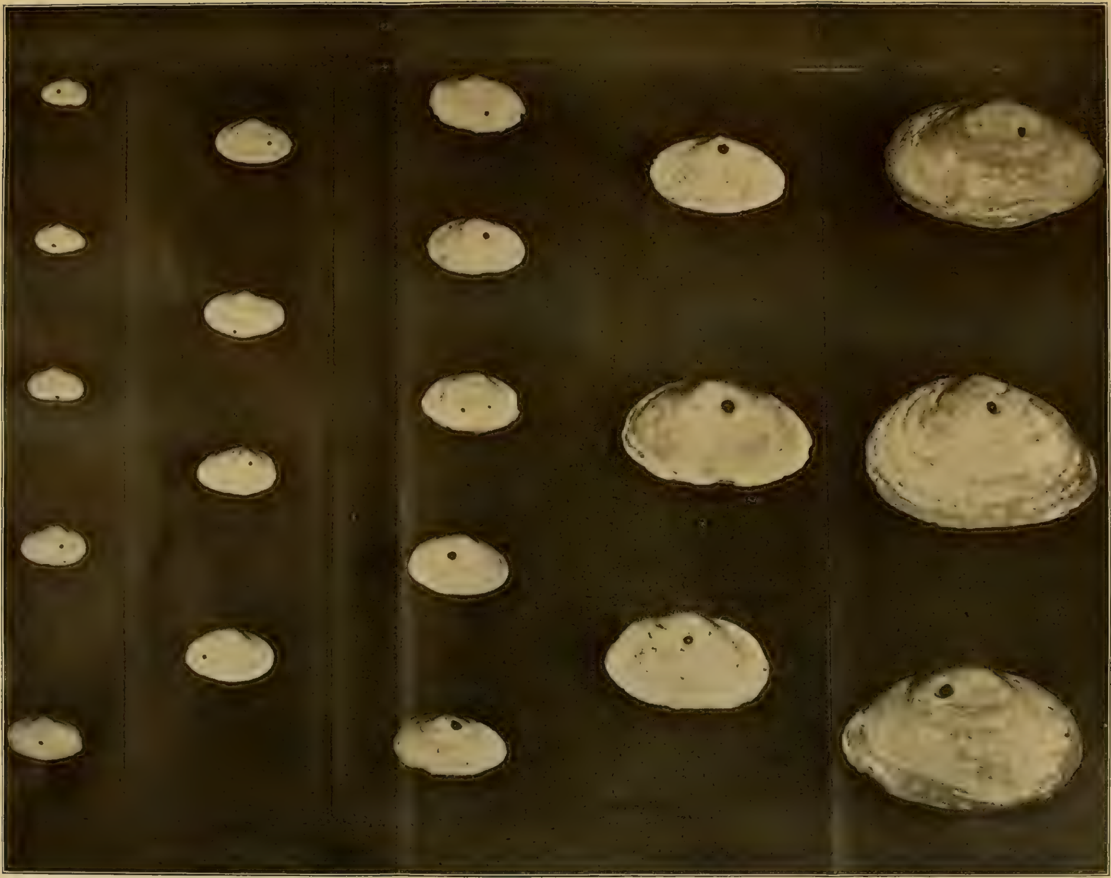


FIG. 7.—Bored clams, showing that clams of all sizes are attacked by the borers.

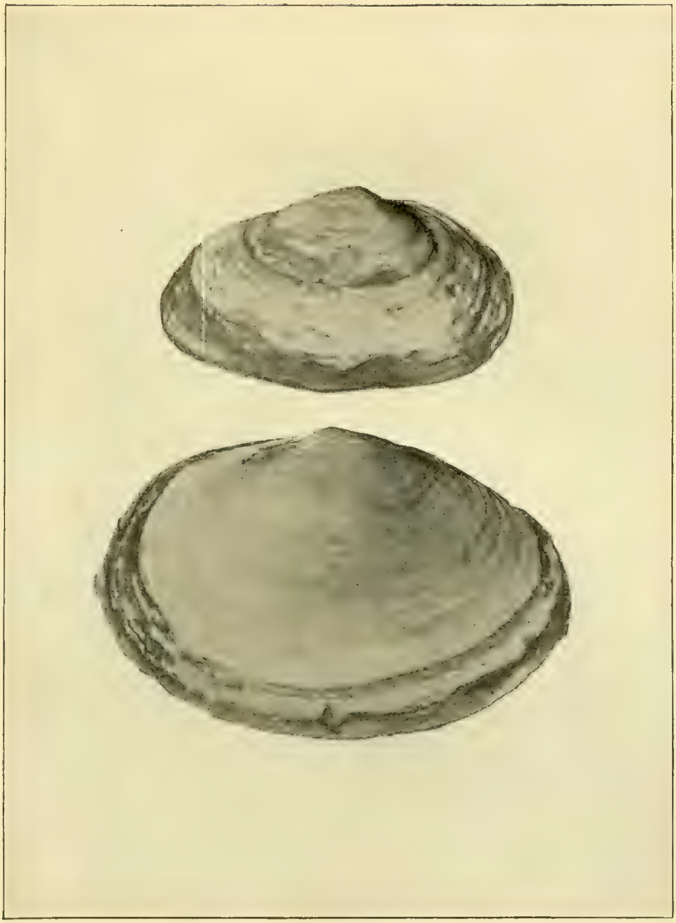


FIG. 8.—Notched clams, showing growth from February 20 to July 6, 1903.
The upper one is from the set of 1902.
The lower one is from the set of 1901.

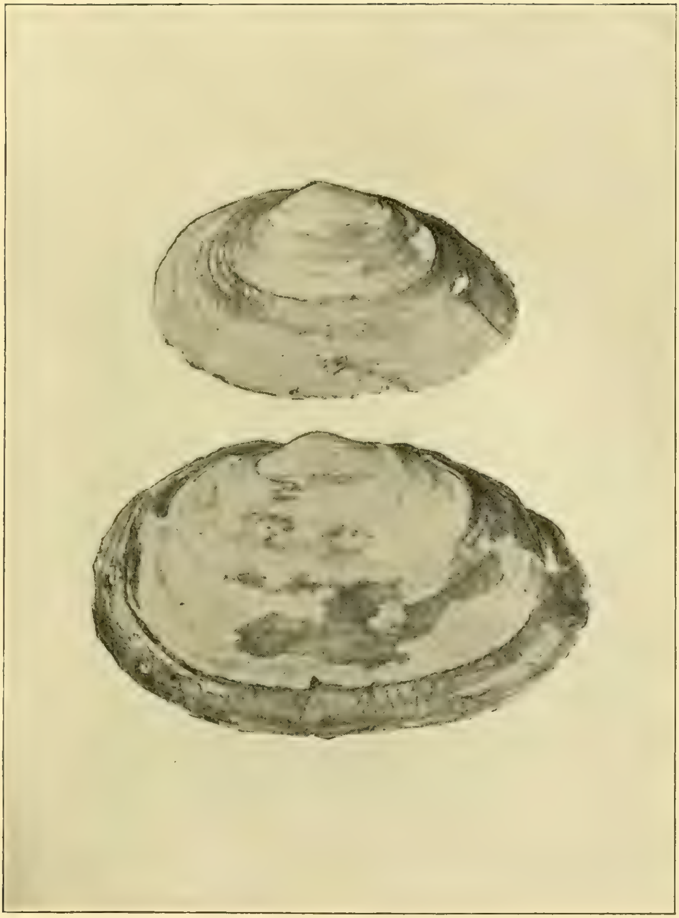


FIG. 9.—Notched clams, showing growth between February 20 and August 10, 1903.
The upper one is from the set of 1902.
The lower one is from the set of 1901.

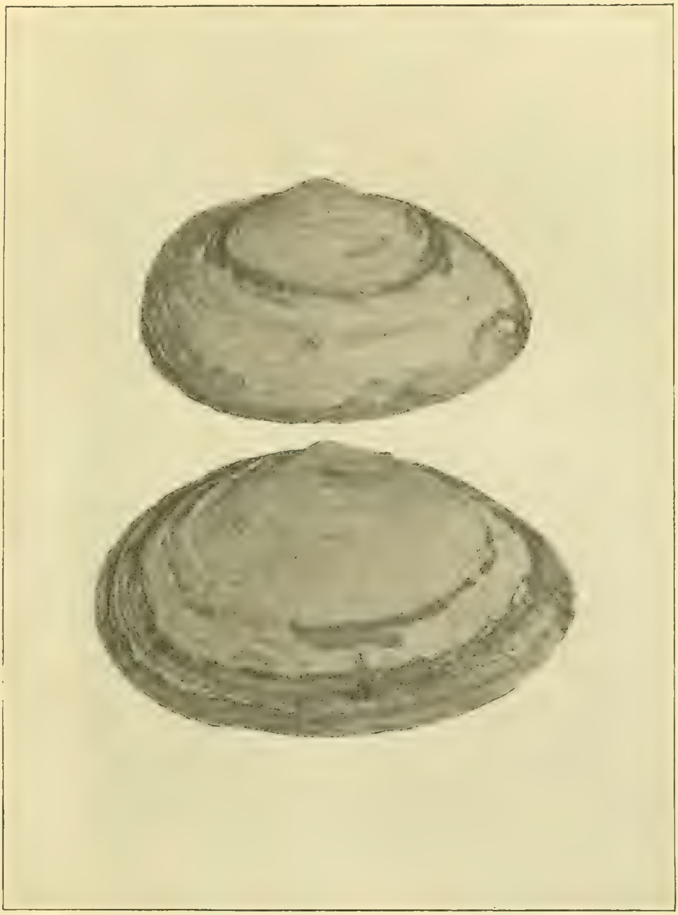


FIG. 10.—Notched clams, showing the growth between February 20 and October 30, 1903.

The upper one is from the set of 1902.

The lower one is from the set of 1901.

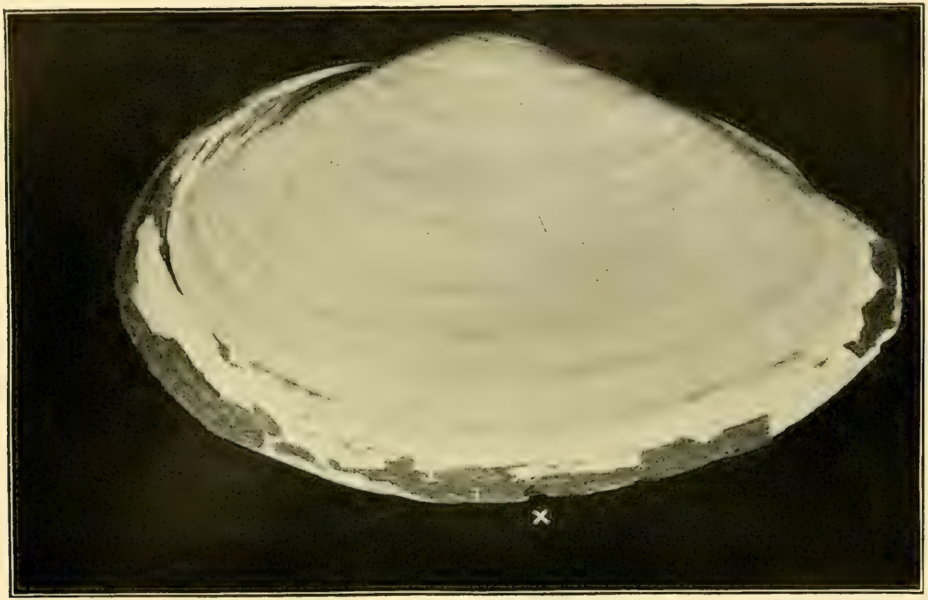


Fig. 11.—A clam of extreme age notched February 20, and taken up October 20, 1903. Shows no growth.

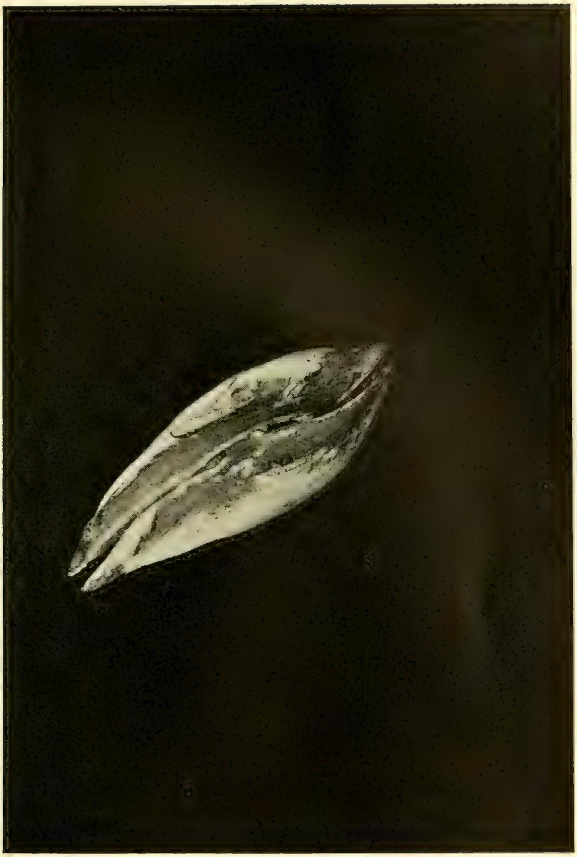


FIG. 11½.—Specimen of clam contorted by developing in stony ground.

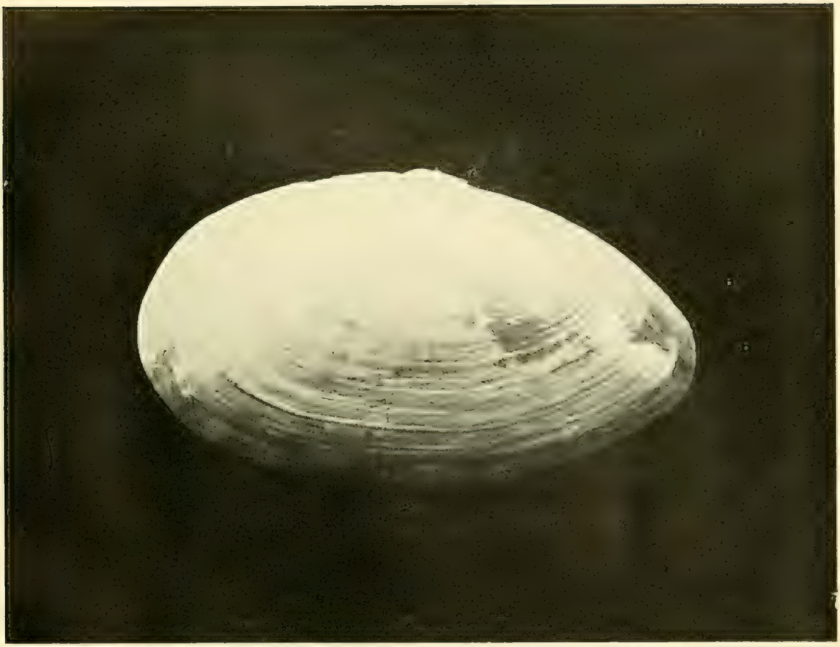
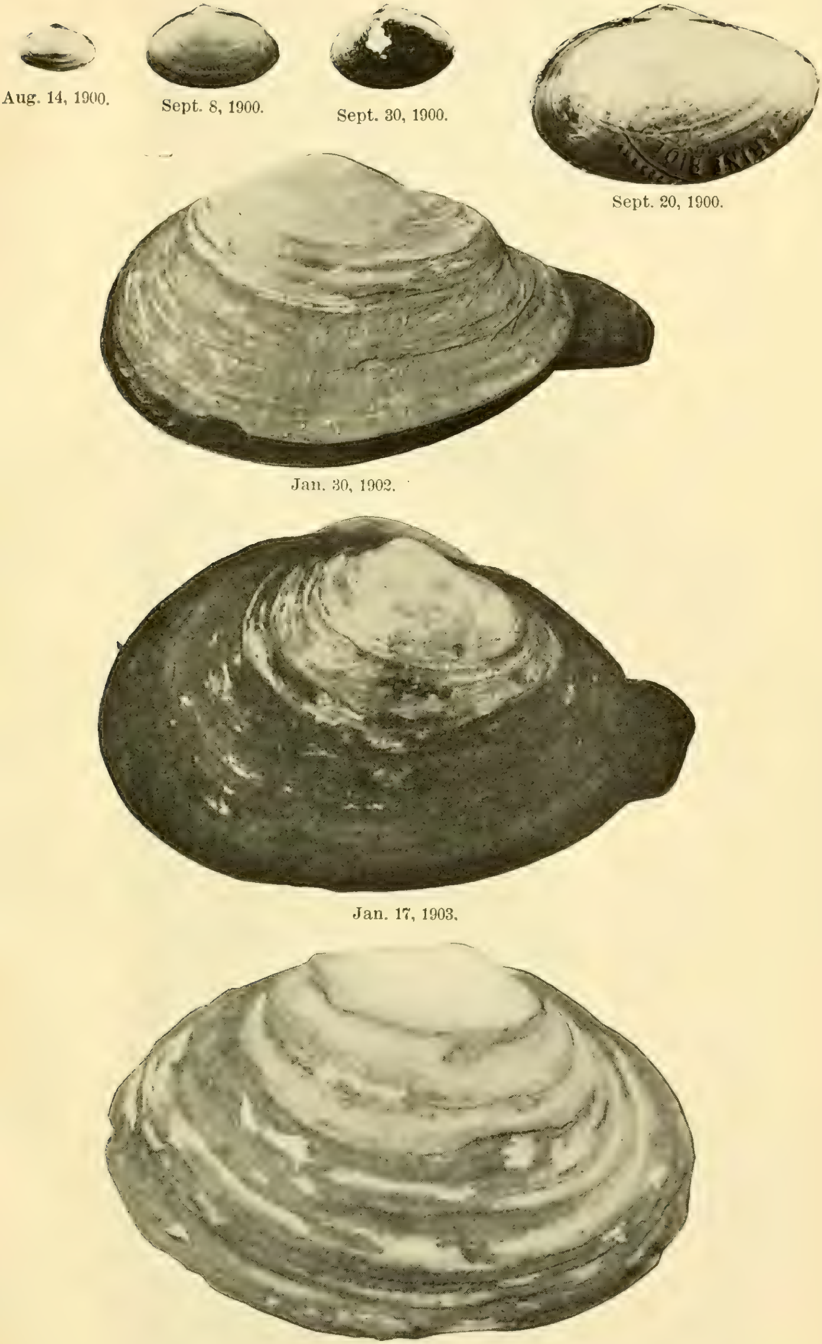


FIG. 12.—One of the land-tile specimens planted July 18, 1899, when of the size of the smaller specimen in Fig. 5, and dug on September 10, 1900. It is, therefore, about a year and three months old.



Aug. 14, 1900.

Sept. 8, 1900.

Sept. 30, 1900.

Sept. 20, 1900.

Jan. 30, 1902.

Jan. 17, 1903.

Oct. 20, 1903.

Fig. 13.—Clams set in the summer of 1900 in clam catcher, and raised in sand boxes. The various specimens, taken at intervals, represent their growth during three years and four months. The difference in size of the two specimens on Sept. 20, 1900, is due to the difference in locality.

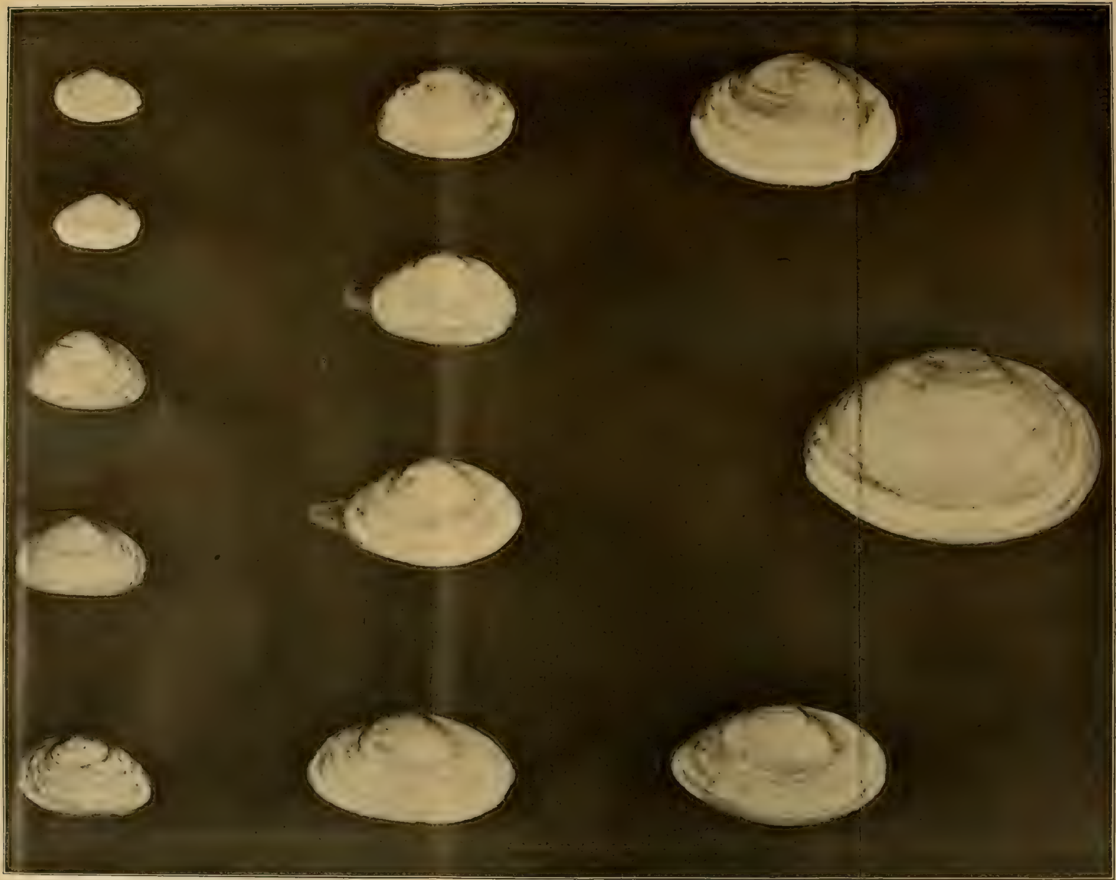


FIG. 14. Stunted clams, showing the effect of excessive crowding. The large clam on the right is from a control bed, where it had plenty of room. All the clams are of the same age (about one year and four months old).

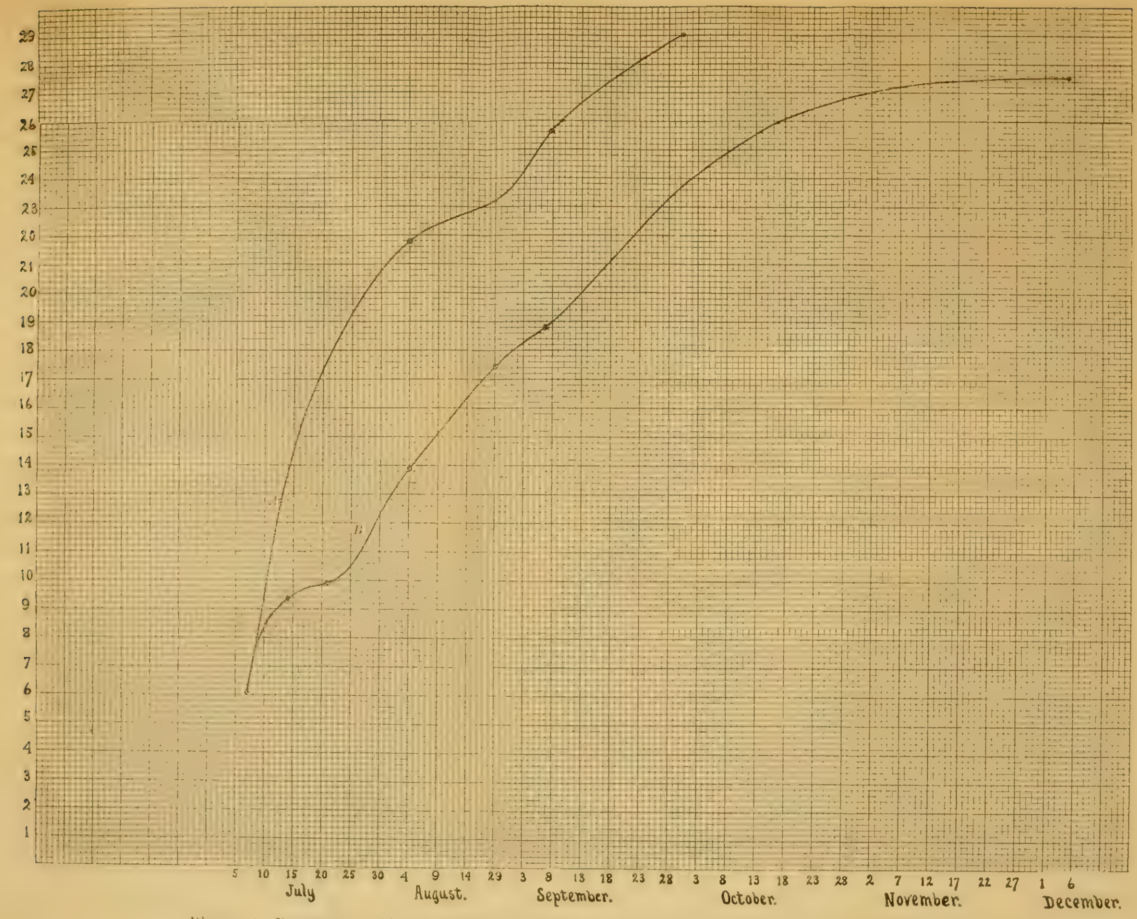


Diagram 1. Represents graphically the difference in growth of clams exposed by the tide and those kept submerged.
Curve A. Clams submerged at the House Boat. (See Experiment No 2, p. 56.)
Curve B. Clams exposed by the tide at Cornelius Island. (See Experiment No. 1, p. 55.)

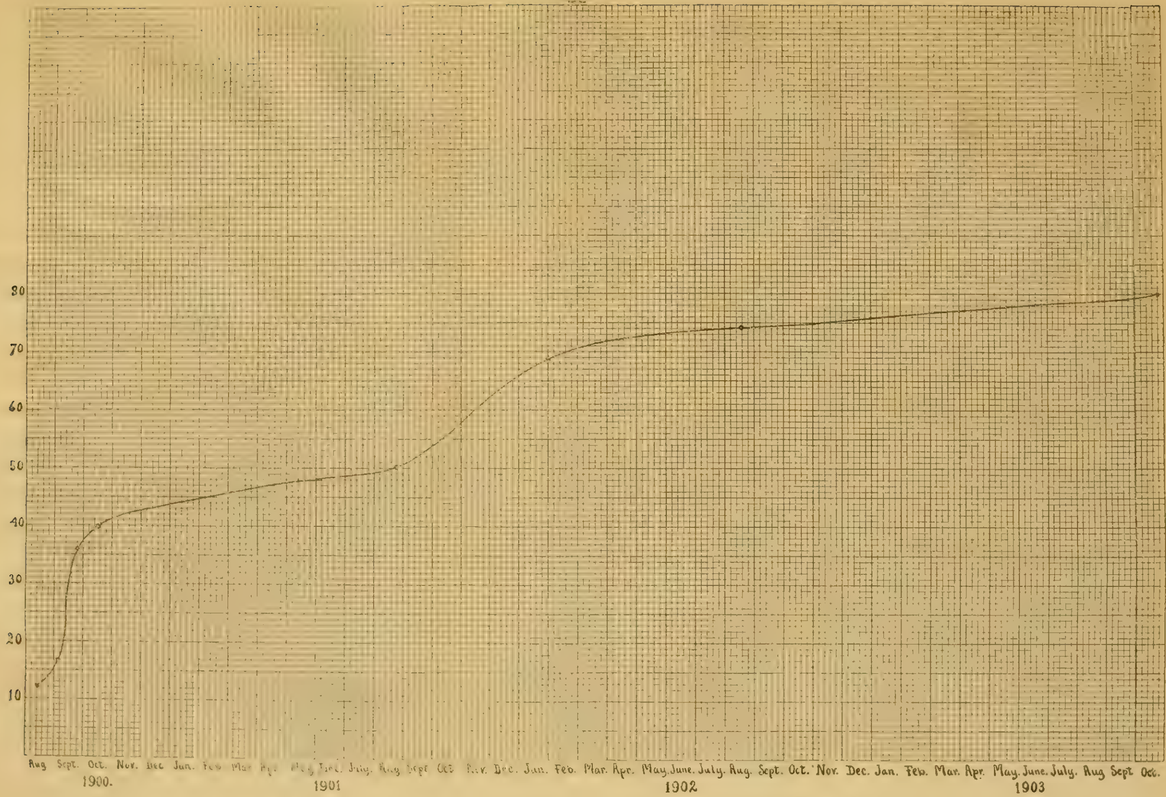


Diagram II. Plotted curve of growth of clams of the "artificial set." (See Experiment No. 5, p. 57.)

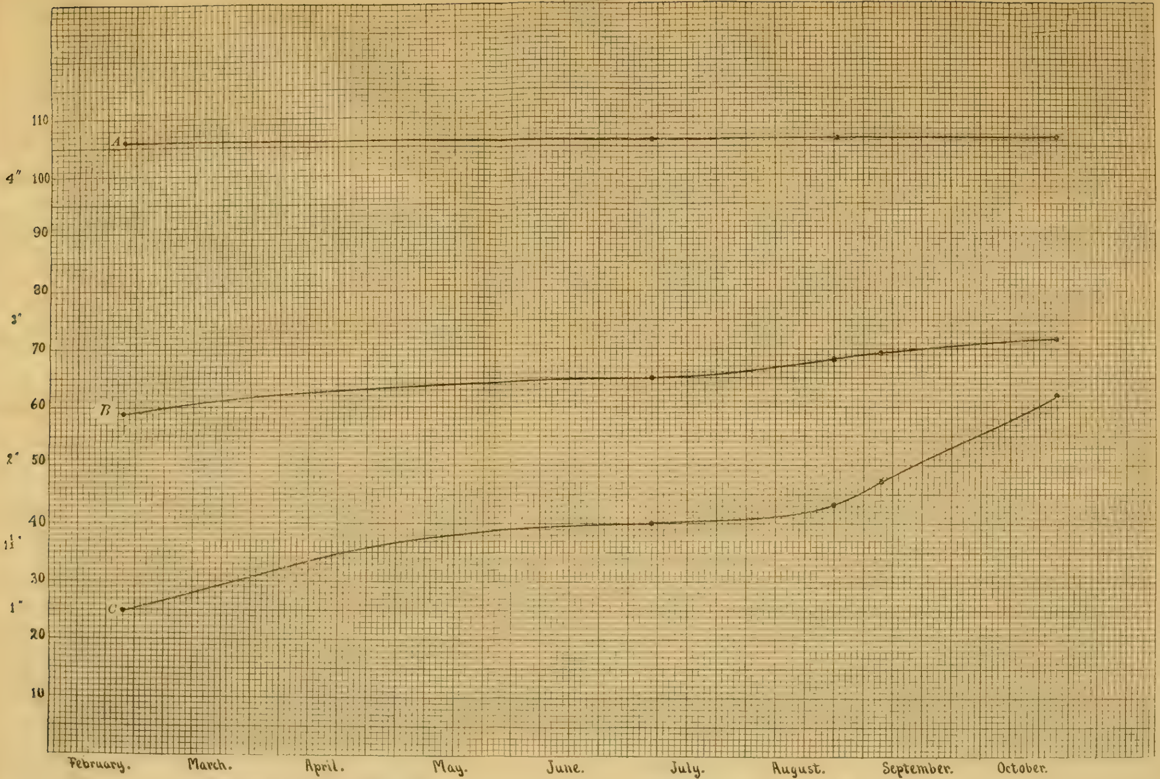


Diagram III. Showing the rate of growth of clams of different ages under the same conditions. (See Experiment No. 8.)
A. Clams of extreme age.
B. Clams from the set of 1901.
C. Clams from the set of 1902.

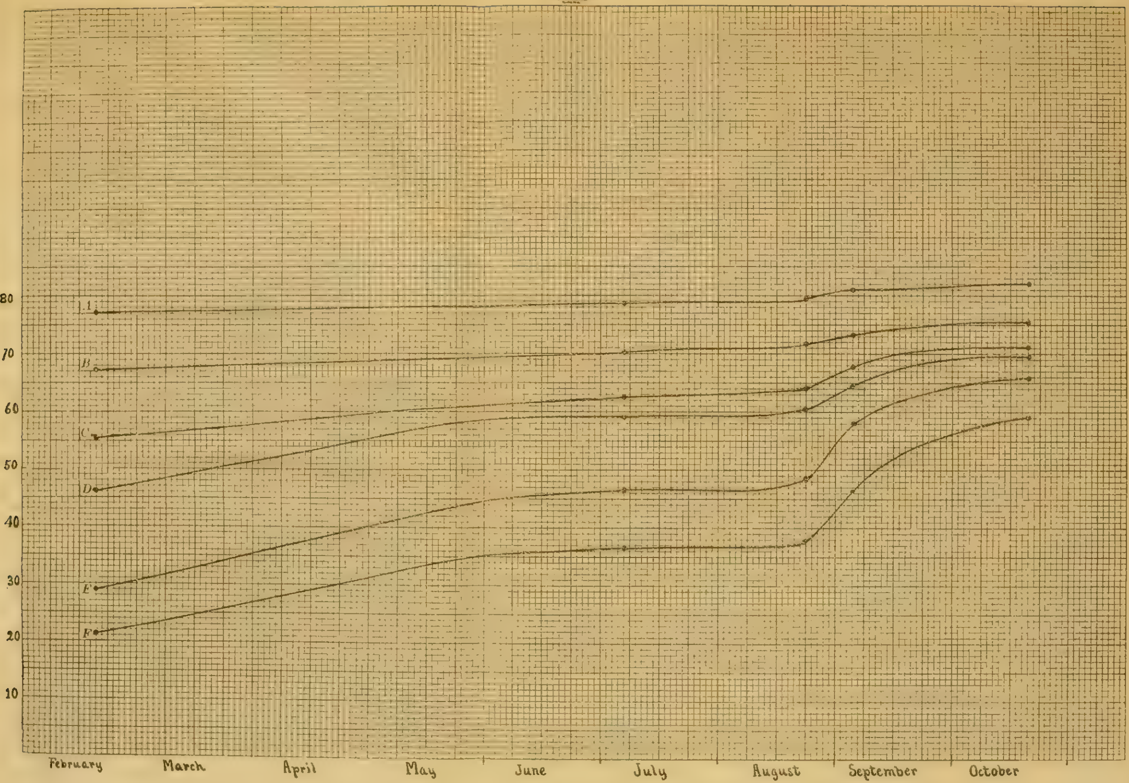


Diagram IV. Showing the rate of growth of selected sizes of clams, regardless of age. (See Experiment No. 8.)
A. Clams 3 inches in length and over.
B. Clams from 2½ to 3 inches in length.
C. Clams from 2 to 2½ inches in length.
D. Clams from 1½ to 2 inches in length.
E. Clams from 1 to 1½ inches in length.
F. Clams under 1 inch in length.

VIII. Preliminary Inquiry into the Natural History of the Paddler Crab (*Callinectes hastatus*), with Remarks on the Soft-Shell Crab Industry in Rhode Island.

Among the minor fishing industries in Rhode Isand, the impounding of edible crabs until they have shed their shells; and the supplying the market with soft-shell crabs, is of no little interest, and judging from the enviable place which this delicious shell-fish holds in the estimation of epicures, from the demand for it in the market, and from the prices it brings, it would seem as though the industry might be developed into one of considerable commercial importance. A preliminary inquiry into the subject was made during the past summer by Mr. E. W. Barnes, whose report is here given:

The Paddler Crab (*Callinectes hastatus*) frequents sandy and muddy shores in sheltered coves and in the mouths of brackish streams from Massachusetts Bay to the Gulf of Mexico. It is known by many local names, the most common in Narragansett Bay being the "edible crab," the "blue crab," the "paddler crab," or simply "paddler." Among crustaceans of economic importance it ranks perhaps next to the lobster. It is used as food, as bait, and even as fertilizer.

The Breeding Season.—The breeding season extends throughout the summer, probably reaching its height in August. The mating of the crabs takes place when the females are preparing to shed, a fact which is taken advantage of by the crab fishermen. For when a pair of crabs are found together, one can be tolerably sure that the female is a "shedder" (that is, is about to cast its shell). From his place of hiding the male suddenly pounces upon the female and turns her over. If she is not ready to shed, he leaves her, but if she is is preparing to moult, the male carries her around with him until the moulting process begins, then, from a short distance, he protects her zealously from eels and from other crabs until the process is completed. The male attends the soft-shell female for about three days.

after which the new shell has become sufficiently hard to furnish the usual protection, and the escort is discontinued. The average number of eggs is about 20,000. They are carried probably throughout the winter attached to the swimmerettes on the under side of the abdomen, or "tail," exactly as in the case of the lobster, until they are hatched.

Moulting or Shedding.—The moulting of both males and females occurs during the entire season, even as late as November. Immediately after the hard shell is shed, the crabs are extremely soft, and, as described by one of the crab fishermen, seem "all to pieces." They have indeed a "watery" appearance. On the under side of the body, between the apparently disjointed limbs, are great spaces which sometimes extend into the body. These spaces not infrequently contain air, which causes the crab to float. If the crabs are turned over, the air bubbles come out, and when the crabs are righted again they behave normally. In a very short time, one or two hours, they "grow together," and commence to harden. During this process the linear dimensions of the crab are increased by about one-sixth, and growth, as in the case of other crustaceans, takes place only directly after moulting.

The time and rapidity of moulting is dependent to a great extent upon the temperature, and perhaps upon other conditions. For example, if the crabs which in the late afternoon are just at the point of moulting are put into a tub of water, they will not moult during the night as they would otherwise, because the water becomes cooled by the night air. The preparations for moulting and the process itself progress more rapidly in warm weather.

The young crabs, like the young lobsters, moult very frequently, but less often the older they become, until at maturity they moult not oftener than once a year. Unlike the lobster, however, the crab may at length reach a period of life after which no further moulting will occur, and the approach of this stage is in the female crab, at least, indicated by unmistakable signs. Shortly before its last moult the bent tail, or "apron," as it is called, becomes throughout streaked or mottled with blue. This peculiar appearance is considered a sure sign, not only that the crab will moult soon, but that, having moulted, the tail will change in shape, become larger and more nearly round. This results in the so-called "half-moon" shape. Female crabs with the "half-moon aprons" have never been known, it is said, to moult or even to show signs of moulting, although they have been kept for a long time in cars and fed generously. Furthermore, specimens of this sort are often caught with barnacles and forests of algæ on their backs, which indicates that a long time has elapsed since they last shed their shells.

The male crabs have no characteristic "aprons" to indicate the close of their moulting period, but as male crabs averaging about the same size have been observed with very hard shells and an abundance of barnacles and seaweed, it would seem as though the males also had a moulting limit. Again, crabs in any particular locality almost never exceed a certain size; and since there is normally a growth of about one-sixth at each moult, this fact is regarded as further evidence that the limit is fixed.

The crabs which are actually preparing to moult become very sluggish and will not eat; and yet, if they are kept in confinement without food even for a comparatively short time before this, the process is much delayed, and afterwards the crabs are light and watery.

Individuals which have moulted require a large amount of food, but ordinarily the crabs may live a long time without it. A story is told, on apparently reliable authority, of a crab which was kept in a car for three months without any food except what was carried into the car by the tide. When finally, out of pity, it was released, it was still lively, and showed no permanent effects of starvation. The writer has kept a specimen over a month without food.

Migratory Movements.—At certain times of the year crabs move off shore regularly before winter sets in, but sometimes also during the summer months. At such times they seem to go suddenly, and disappear from all parts of the Bay at the same time. Fishermen who have had long experience with them say that the crabs migrate into deeper water and are often caught there. The reasons for these migrations and exact information concerning them have not as yet been obtained. In the winter the crabs are pretty generally absent from the shores, but sometimes they are found buried in the sandy mud near shore. Those which have migrated begin to return toward the latter part of May or the first of June, and remain sometimes as late as November.

The Soft-Shell Crab Industry.—In some parts of the bay, especially at Narrow River, there are several fishermen who make a regular business of supplying the market with this species of soft-shell crabs. The product returns several thousand dollars each year.

It would be difficult or impossible to supply the demand by merely catching the crabs in the soft-shell condition. The industry depends upon ingenious methods of distinguishing the crabs which are about to shed their old shells, of impounding and feeding them until they have shed and are in proper condition, and of retaining them in the soft-shelled condition, and packing them for safe shipment.

The crabs are caught by means of long-handled nets, and a special lookout is kept for those which are moving in pairs, because, as we have already stated, in such cases one of the pair is likely to be a female about to shed or which has just finished shedding. There are also special factors, some of which we have mentioned, which distinguish the crabs that are about to shed. Thus a crab is suspected of being a shedder if its movements are sluggish and it does not move away quickly; if it has lost a limb, and has the new one partly regenerated; if it has a hard, dull-looking shell.

The final criterion, however, is the appearance presented on breaking off one of the points of the shell. If the piece of shell comes away and leaves the core sticking out of the break, the crab is certainly a shedder, but if, on the other hand, the wound thus made presents a milky appearance, the crab is not a shedder.

Crabs which are judged to be about to shed are placed in a floating car, where they are kept in separate compartments until the shell breaks open, then they are transferred to another car where they are kept all together, and from which they are picked out as soon after they have finished moulting as possible, and are packed and shipped.

Having obtained the crabs in the required soft-shell condition, it is of equal imporance to keep them alive in this condition until they pass into the hands of the chef. Under natural conditions the shell will harden in a very few days. To obviate this an ingenious method is employed. At the proper time, soon after they have shed, the crabs are packed in damp seaweed or eel grass, and there they will remain alive for a long time, but the shell will not harden. If, however, seawater be added to the seaweed so that it becomes wet instead of merely damp, the shell commences to harden and what is known as the "paper-shell" crab is produced.

The crabbing season extends from the first of June until the last of September, but the crabs are sometimes caught as early as the last of May and as late as the beginning of November. The better summer resorts furnish an excellent market at high prices. Newport, Saunderstown, and Jamestown pay about $1.00 per dozen. The regular price in the Providence market ranges from about 50 cents to 75 cents.

The soft-shell crab industry is carried on to a greater or less extent in New Jersey, Delaware, Virginia, and South Carolina. Besides the paddler crab, at least four other species are used in this industry, viz., the lady crab (*Platyonichus ocellatus*), stone crab (*Menippe mercenarius*), and rock crab (*Cancer irroratus*).

IX. Experiments in Lobster Culture.

In the report for 1902 we submitted, under this heading, an article in which were brought together the results of our investigations of the lobster and the methods of its propagation up to that date, together with other observations, made by Herrick, Bumpus, etc., which have a direct bearing on the subject. We may refer, therefore, to the last report for a discussion of the following subjects: the geographical distribution of the lobster, and its distribution relative to the depth of the water; its breeding habits, including the time, place, and frequency of breeding, manner of depositing and caring for the eggs, number of eggs deposited, and the method of their dispersement; age and size attained before breeding begins, and the numerical proportion of males and females; the habits of the young fry, their movements, their food and manner of feeding, their natural enemies, their adjustment to physical conditions, such as temperature and density of water, their rate of growth, manner and frequency of moulting, the changes in structure and habits which accompany the early moults; the habits and requirements of the young lobsters which have passed through the earliest stages; the rate of growth and age of lobsters up to the marketable size; the migration of adult lobsters along the shore and to and from the waters of adjoining States; their migrations to and from deep water; the rate of growth of large lobsters, and the extreme age to which lobsters may live and breed; the problems of hatching the eggs artificially in such a manner as to increase the natural number of fry, and of depositing the newly hatched fry where the conditions are more favorable than those which surround them when deposited naturally; the possibility, feasibility, and the methods of confining, feeding, and protecting the young fry until they can take care of themselves much better than when they are first hatched; and the possibility, feasibility, and methods of rearing the lobsters from the egg to maturity in confinement.

The main problem, and, at the same time, the chief difficulty, in the artificial propagation of lobsters consists in rearing the newly hatched, free-swimming fry through the *critical* period of about two or three weeks. This is a definite period which is passed as soon as the fry shed their skins three times. At each moult the young lobster appears in a different form and of a larger size, and there is no difficulty in recognizing the successive stages. It is the critical period for the reason that, until the eggs are hatched, they are well protected by the mother, and after this period has expired the fry assume almost the likeness of the adult form, and in great measure quit their precarious swimming life, and begin, for the first time, to burrow and crawl, hide and fight, at the bottom of the sea.

The difficulty in rearing fry through this period in any considerable numbers consists in so confining them that they will not die from the effects of suffocation, mechanical shock, starvation, cannibalism, or parasites. A large number of experiments were tried by ourselves, as well as by others, before we hit upon the principle upon which we have based our operations during the last three years. The principle is simply this: the water must be stirred constantly, and the lobsters and their food kept suspended in the water.

The first apparatus built on this principle was installed in 1901, and was highly successful. In 1902 a number of important changes were made in the construction of the apparatus, and nearly all of them turned out to be improvements. Few alterations were made during the past season, but some were suggested by the experiments that will, it is hoped, in the future, improve the efficiency of the apparatus. For a detailed description of this apparatus and the results obtained up to the past season, we must refer the reader to the last report.

During the season just past all the fry which were used were hatched at our own station with this same apparatus, while heretofore we have depended in part on importations from the United States Fish Commission at Woods Holl. The hatching was carried on successfully and on a larger scale than ever before. Several experiments in new methods were tried, the results of which furnished a large amount of information as to the details of construction which will be of use in the future.

Few changes were made in the method of rearing the fry, and during the first half of the season there was promise of a better output than ever before. In the midst of the season, however, a southeast storm, one of the most severe in many years, broke over the Bay, and although ample provision had been made against an ordinary storm, many of the fry were lost. Hardly any damage was sustained by the apparatus, but the storm shields of the side floats were carried away, and the waves had free access to the large bags which contained the fry. The loss of fry could doubtless have been made good had it been possible to obtain more lobster eggs, but the storm had also carried away the lobster pots or their buoys in all the Rhode Island waters, and before the lobstermen had repaired damages, the season for procuring eggs was past.

The total output of the lobsterlings for the season was 13,500, against 30,000 for the year before. These lobsters were liberated as follows: 1,500 on the south shore of Mill Cove, Wickford; 5,000 near the White Rocks; 5,000 on the rocky shore of Little Tree Point; 2,500 on the west shore of Conanicut. The decrease in the number of lobsters reared to the fourth stage was through no fault of the principle, the method, or the apparatus with which we are working.

We believe that the problem which we attacked, namely, that of rearing lobster fry through the critical period, has been solved, and that, at present, the hatchery is a benefit to the industry. This will not, of course, be construed as a statement that no further progress can be made toward perfecting the method or increasing the efficiency of the apparatus.

Aside from the regular work of hatching, much attention has been given to the improvement of minor details of the apparatus. For example, improvements in the transmission machinery, in the manner of fastening the large bags to their frames, so that they can be more readily raised, and so that the bottom will not be bowed

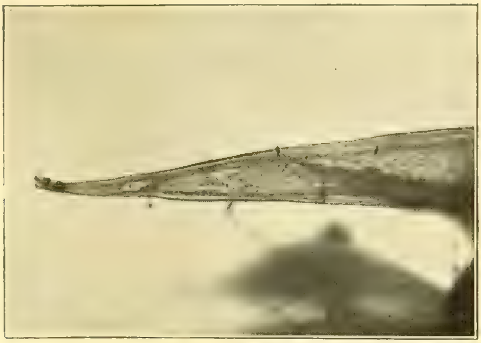


FIG. 15.—Rostrum of a lobster of the first stage. Magnified 50×.

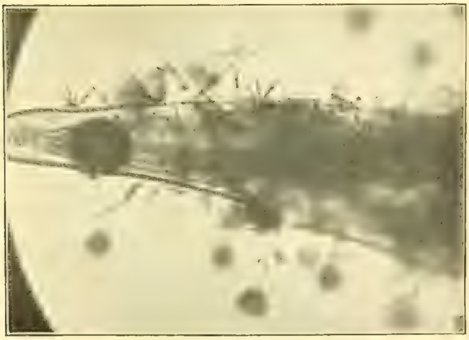


FIG. 16.—Rostrum of a lobster of the third stage. Showing how they become covered with diatoms. Magnified 50×.

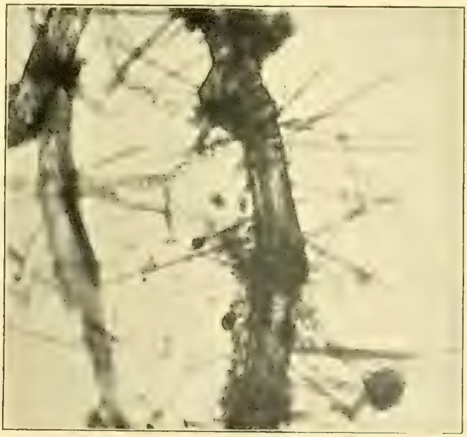


FIG. 17.—Algæ found growing on the sides of the lobster bags.

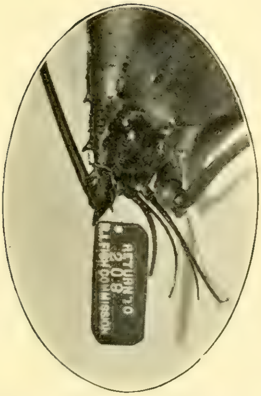


FIG. 18.—Illustrating the method of tagging the lobsters.

upwards and interfere with the movements of the propeller, in the manner of transmitting and counting fry, etc., etc. These things, however, are not of general interest, though they are important steps in the progress of the work.

The growth of parasites on the bodies of the young lobsters constitutes one of the most serious difficulties now left for us to contend with. Oftentimes young lobsters are seen to have a fuzzy growth on the body and on the limbs (See Figs. 15, 16 and 17.) Under the microscope this growth is resolved into a tangled mass of diatoms and stalked protozoa, which, though they are probably not true parasites, often so encumber the movements of the lobster and interfere with its feeding and moulting as to finally cause its death. The growth is found most often on lobsters in the third stage. There are two possible reasons for this: in the first place, the bags containing the lobsters of this stage have usually been in the water for more than a week, and the microscopic forms collect in great numbers on the walls of the bag (see Fig. 17), so that perhaps the lobsters become infected from contact with them here; in the second place, the third stage is of longer duration than the two preceding ones, so that the parasites have a longer time in which to settle and grow; for with the shedding of the skin, of course, the parasites are thrown off. Why they are more abundant in the latter part of the season (July) is not easily explained. They are not so serious a menace to the life of the lobster under the present method of operation as they were in the older experiments, when the lobsters were not stirred. In the season preceding the installment of the present apparatus, some of the specimens were so thickly overgrown that they showed no resemblance to a lobster or any other living creature. We may perhaps also congratulate ourselves that this pest is not so abundant at our station as it is in other localities, for example, at Woods Holl.

How to combat or avoid this evil is a problem yet to be solved. Extermination is, of course, out of the question. Experiments in shading the bags were tried at Woods Holl. A screen was put up to keep off the sun, in the hope that this would retard the growth of the parasites, and the effect was apparently beneficial. This has not been tried at Wickford. Much can be accomplished, perhaps, by changing the bags more frequently, and especially by transferring the lobsters which have just entered the third stage into clean bags. Various other devices have been suggested, but their practicability can be proved only by experiment.

The method of liberating the lobsterlings after they have been carried through the fourth stage calls for careful consideration. There are, at first glance, several chances to be weighed and considered. First, the chance of their finding a satisfactory place to burrow and hide; second, the chance of their avoiding enemies; and third, that of obtaining suitable food. If the lobsterlings are simply turned overboard and scattered here and there in the midst of the Bay, they, of course, have the same chance of becoming suitably settled in life as those which reach this stage under natural conditions; but, if we are to follow up the advantage gained by protecting the lobsters so far, we must study carefully their habits and requirements after this stage is reached. We have already made many observations on the lobsters at this stage under conditions as nearly natural as can be expected when they are confined in small cars, protected from their enemies and fed artificially. In these cars, which are furnished with sand, gravel, shells, stones, broken tile and sea-weed, their habits of burrowing, choice of hiding places, the time of day when they remain concealed and when they forage, can be observed; but we know practically nothing of their movements when, for example, they are liberated in deep water. A careful study of their behavior after they have been liberated must be made in order to obtain the best results.

What we already know of their habits has suggested two methods of liberating. One is to put them overboard in a car to which they have become accustomed, and which is provided with a wire netting or some other device, so that the lobsters can leave the car, while their enemies, fishes, crabs, etc., are kept out. There is an obvious disadvantage in throwing overboard a large number of lobsters at the same point, for such a swarm would be likely to attract large numbers of fishes and other enemies.

Another method has been suggested and tried, as follows: the lobsters are liberated upon a stony shore when the tide is out. The ground is so wet and little tide holes so frequent that the lobsters can burrow and hide. As the tide gradually comes in it is expected that they will find themselves comfortably located, and will not swim about in excitement and expose themselves to capture. Ground which is free from sea-weed and large masses of rocks is also less frequented by mummychaugs and eels. Above all, they should be liberated in the morning, or at least not in the late afternoon, for both they and their enemies are especially active at night.

The migration of lobsters is an important subject, which at present is not very well understood. In order to obtain some definite data in respect to the movements of individual lobsters some interesting experiments were made in 1898 by Dr. Bumpus, at that time a member of this commission and director of the Scientific Laboratory of the United States Fish Commission at Woods Holl.*

Four hundred seventy-nine lobsters from which the eggs had been removed were tagged† and liberated at several points near Woods Holl. Later, seventy-six of these were recaptured by fishermen, and the copper tags were returned. Many other tagged specimens were doubtless caught which were not heard from, and some lobsters probably moulted and so lost the tags.

The data gained by these experiments, however, showed great variation in the movements, and a remarkable rapidity of migration in certain cases; while many of the lobsters were recaptured in the same locality three or four weeks after they were liberated, others had travelled at an average rate of a mile a day for from ten to twelve days. One, for example, was liberated at Woods Holl, on July 2nd, and was caught at Cuttyhunk, twelve miles distant, on July 13. It had travelled twelve miles in eleven days. Whether these specimens were seeking better food, warmer water, deeper water, whether they were following a general direction, or were impelled by a home instinct, cannot at present be said with certainty.

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*"H. C. Bumpus on "The Movements of Certain Lobsters Liberated at Woods Holl during the Summer of 1898." Bulletin of U. S. F. C., 1899.

†For method of tagging see Fig. 18.

Similar experiments were tried at Wickford by your commission in 1902 and 1903, and the results are given in the accompanying tables. These experiments showed a similar variation in the movements of the lobsters, and the record for fast travelling is at present held by our specimen No. 103 (see table), which travelled ten miles in eight days. Another suggestive fact is brought out by these experiments, and was emphasized by Dr. Bumpus, namely, that a comparatively large per cent. of the specimens were caught and the tags returned within a very short period. This shows that a thorough gleaning is continually being made of the lobster crop. The suggestion is further emphasized by the fact that some of the lobsters were known to have been caught and the tags held back by the fishermen, and doubtless there were other similar cases which were not heard of. Furthermore, lobsters which have recently got rid of their eggs are known to be especially liable to shed, and with shedding the tag is lost.

Important observations on the migrations and growth of lobsters might be made, if we could devise a method of marking them with a distinctive and conspicuous label that would not be lost when the shell is shed.

Table Showing the Movements of Female Lobsters from which the Eggs have been Stripped, Which Were Liberated at various places during the Summers of 1902 and 1903, Each Lobster Bearing a Copper Tag, with the Words, "Return to the Rhode Island Fish Commission."

LOBSTERS LIBERATED IN 1902.

Tag No.	LIBERATED. Locality.	Date	RECAPTURED. Locality.	Date.	Number days free.	Distance in miles (statute).	Direction.
147	Wickford Light House..	July 7.	Whale Rock Light.........	Aug. 1.	25	9	E. of S.
103	" " "	" 7.	1 mile S. W. Beaver Tail..	July 15.	8	10	E. of S.
5	" " " ..	June 4.	2 miles S. Beaver Tail.....	" 7.	33	11	E. of S.
25	" " " ..	" 4.	South end Conanicut......	Aug. 18.	75	7	E. of S.
22	" " " ..	" 4.	....	July 1.	27	....	E. of S.
36	" " " ..	" 5.	West Passage.............	....	....	....	E. of S.
[illegible]	" " " ..	" 7.	West Passage......... ...	....	...	....	E. of S.
148	" " " ..	July 7.	West Passage.............	....	....	....	E. of S.
[illegible]	" " " ..	" 7.	West Passage.......... ...	....	...	....	E. of S.
[illegible]	" " " ..	" 7.	West Passage............	....	....	....	E. of S.
43	" " " ..	June 5.	1 mile S. of Plum Beach...	June 8.	3	4½	E. of S.
58	" " " ..	" 7.	Coon's Ledge............	" 27.	20	1	N. E.
75	" " " ..	" 21.	Wickford Light House....	" 28.	7	0	....
18	" " " ..	" 4.	Stone Beacon, Wickford..	" 16.	2	1	N. E.
149	" " " ..	July 7.	Whale Rock..............	Aug. 10.	34	9	E. of S.

Number liberated.................................... 112
Number recaptured...... 16

LOBSTERS LIBERATED IN 1903.

Tag No.	LIBERATED. Locality.	Date.	RECAPTURED. Locality.	Date.	Number days free.	Distance in miles (statute).	Direction.
163	N. end of Conanicut Is..	May 27.	West Conanicut...........	June 18.	22	1	E. of S.
199	" " " "	" 27.	South end Gould..........	July 2.	36	4	E. of S.
219	Wickford Light House..	" 27.	Beaver Tail................	" 11.	45	10½	E. of S.
239	N. end of Conanicut....	" 27.	West Conanicut...........	June 18.	22	1	E. of S.
242	Wickford Light..........	" 27.	Little Tree Point..........	" 11.	15	1	E. of S.
269	N. end of Conanicut.....	" 28.	East Passage..............	May 30.	2	2	E. of S.
272	Wickford Light.........	" 28.	Beaver Tail................	July 25.	58	12	E. of S.
278	N. end of Conanicut.....	" 28.	South Gould Island.......	May 30	2	3½	E. of S.
288	" " "	" 28.	Rose Island................	July 3.	36	6	E. of S.
293	" " "	" 28.	North of Gould Island....	May 30.	2	2½	E. of S.
294	Wickford Light.........	" 28.	West Conanicut...........	June 26.	29	3	S. of E.
309	" "	June 2.	Beaver Tail................	July 20.	48	10	E. of S.
311	Fox Island...............	" 2.	Cold Spring Rock..........	June 29.	27	1	W. of N.
324	"	" 2.	Beaver Tail................	July 25.	53	8½	E. of S.
330	"	" 2.	Ledge Rock...............	June 26.	24	1	W.
331	"	" 2.	Cold Spring Rock..........	" 13.	11	1	W. of S.
336	"	" 2.	Brenton's Reef.......	" 24.	22	11	E. of S.
351	"	" 2.	Beaver Tail................	July 30.	58	8½	E. of S.
364	"	" 2.	Little Tree Point..........	June 18.	16	¾	W. of S.
372	"	" 2.	Cold Spring Rock..........	July 3.	31	1	W. of S.
385	"	" 2.	Beaver Tail................	" 28.	58	8½	E. of S.
386	"	" 2.	" "	" 31.	59	9	E. of S.
387	"	" 2.	Little Tree Point..........	June 11.	9	1	W. of S.
389	"	" 2.	West Passage.............	July 16.	44	2	E. of S.
401	"	" 2.	Beaver Tail................	" 31.	59	8½	E. of S.
434	Between Fox Island and White Rocks..........	" 2.	" "	" 25.	53	8½	E. of S.
459	Vials Creek Rock........	" 4.	West Passage.............	" 16.	42	4	E. of S.
500	" "	" 4.	" "	" 16.	42	4	E. of S.
535	" "	" 4.	Beaver Tail................	" 26.	54	11	E. of S.
566	Mill Cove................	" 4.	" "	" 7.	35	11	E. of S.

Number liberated..385

Number recaptured...... 30

CHART II.

A chart showing the places where tagged lobsters were liberated in 1902, and the places of their recapture.

The circles indicate the place where liberated, the black dots the place recaptured, and the dotted line the path supposed to have been traveled. Thus, the dot bearing the numbers 5 VII-7 means that the lobster bearing the tag No. 5 was recaptured the 7th of July and was liberated the 4th of June.

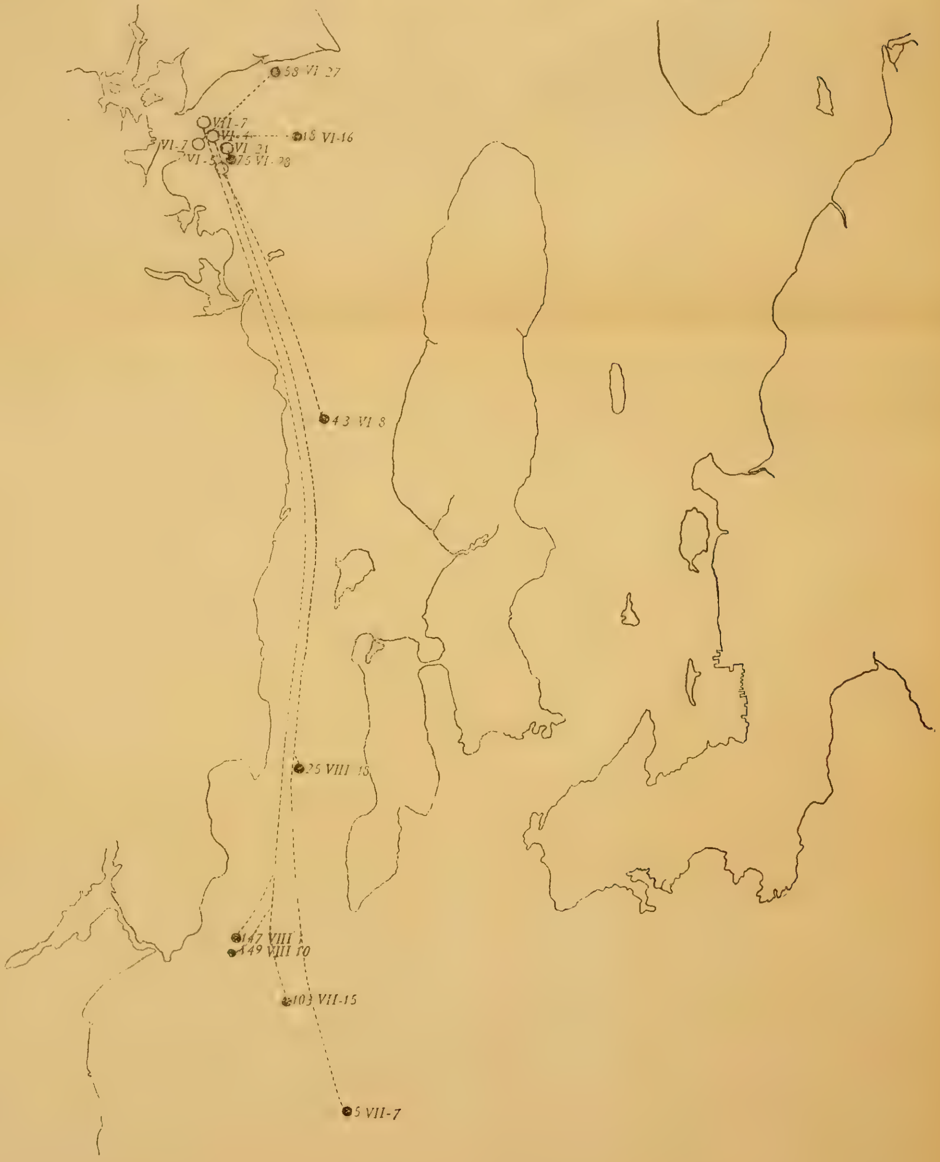
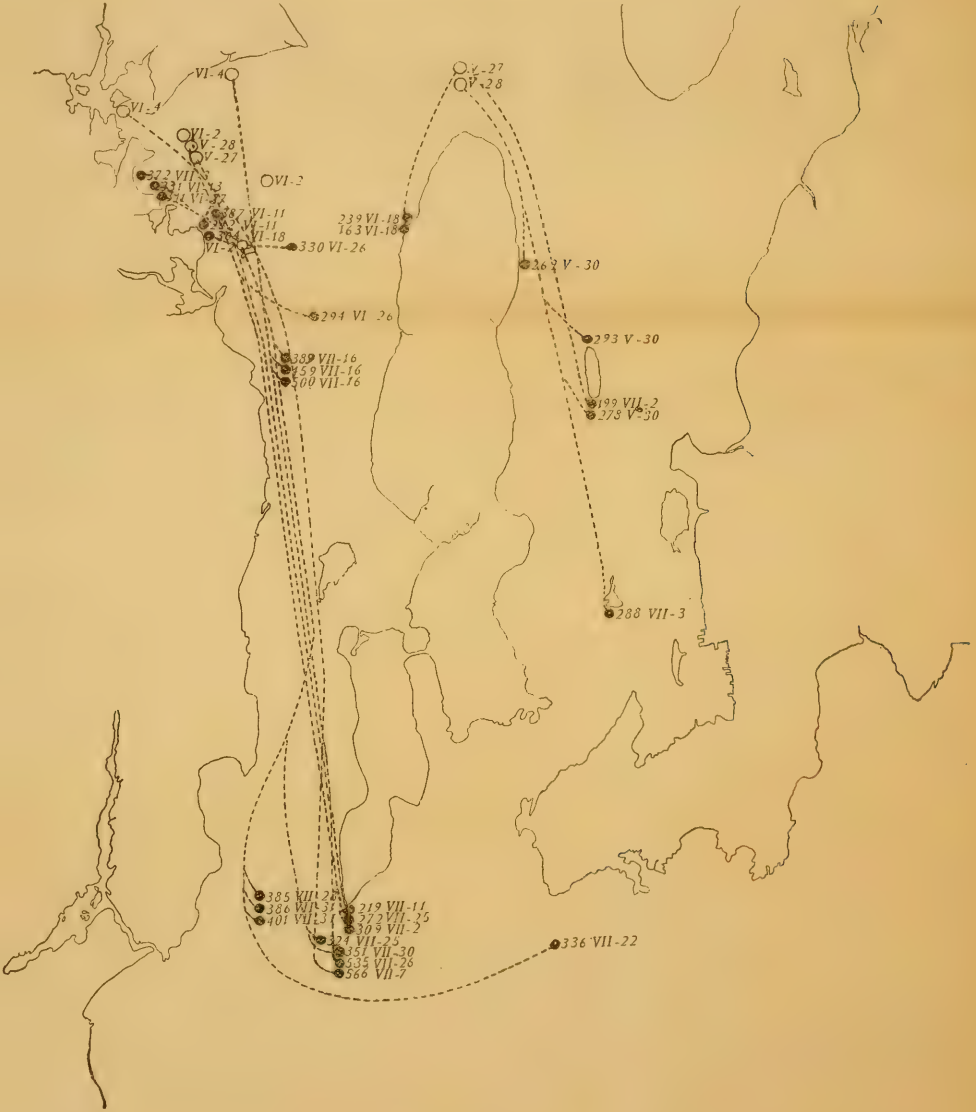


CHART III.

A chart showing the places where tagged lobsters were liberated in 1903, and the places of their recapture.

For explanation of the figures, see Chart II.



X. The Efforts of the Commission to Prevent the Illegal Taking of Short Lobsters.

During the past year your commission has continued its efforts in this direction. Several deputies have constantly been employed in enforcing the law, and, though it is possible that some short lobsters are smuggled into the market, it is certain that the effect has been to greatly lessen this illegitimate fishing. During the months of Dec., 1903, and Jan., 1904, about 2,000 short and egg lobsters, shipped into Newport from outside the State, were liberated in our waters.

One of the most encouraging features in this department of our work is the hearty support and sympathy of many of the leading lobster dealers, who recognize in the enforcement of the law a benefit to their business.

XI. THE PREPARATION AND EXHIBITION FOR THE LOUISIANA PURCHASE EXPOSITION.

Your commission has prepared for the St. Louis Exposition an exhibit to represent the investigations on the life history of marine food animals of Rhode Island and methods of their artificial propagaton. Inasmuch as some of this work was done in collaboration with the United States Fish Commission, the exhibit is to be installed in the United States Fisheries Building. The following is a brief explanation of the nature of the exhibit.

A collection of specimens has been made and arranged to illustrate, as far as possible, the features of economic importance which our investigations have brought out:

1. A series of about fifty groups of clams illustrates the rate of growth of these specimens during the first three years under various conditions, location, soil, transplanting, etc.

2. A series of twenty groups of scallops illustrates the growth of these animals during the first two and a quarter years and shows the origin of the growth ring, by means of which seed scallops may readily be distinguished without reference to size. The great majority of scallops fail to reach the age of two years, and it is generally believed that all die before arriving at that age. A continuous investigation, however, has revealed the fact that some specimens live through the second year and probably breed a second time. A second ring of growth also appears on the shell at the beginning of the third year of life which is similar to that appearing at the beginning of the second year. The exhibit contains specimens of scallops two years and four months old showing the two growth rings.

3. A series of star-fish illustrates the larval swimming form, the manner of setting, the change of the larvæ into the adult, and the rapid growth of the star-fish up to the time when each arm is 1½ inches long. The most extraordinary difference in the rate of

growth between specimens richly provided with food and those which are starved is illustrated by two individuals of the same age which were kept under these different conditions. The age of all specimens (dating from the time of setting) is definitely known.

4. The series of specimens showing the male and female lobsters, the lobsters bearing the eggs attached to the swimmerettes, the successive stages in the development of the lobsters from the time of hatching to the third year of age, and specimens showing the manner of moulting. The lobsters of the later stages represent the only ones ever reared in this country, with the possible exception of one or two specimens kept over winter in an aquarium. These lobsters were all carried through the winter in cars which were sunk in Wickford harbor.

5. An exact reproduction of the floating laboratory or house-boat of the commission, rigged with the lobster raising apparatus is represented by a model executed entirely in copper by Mr. F. E. Stark, of Brown University, and Mr. Knapp. This model will be installed in a tank of water with its machinery in motion. It is of special interest as it is a model of the first successful lobster raising apparatus.*

6. A series of specimens exhibited under the microscope showing the characteristic appearance of lobster fry of different stages and the parasitic forms which sometimes infest them.

7. A plaster model shows the configuration of the bottom of Narragansett Bay and of the surrounding land. The model is accurately made from the soundings appearing upon the government chart and the counter lines which are given in the topographical map issued by the government.

The general merit of the exhibit is that, with a few exceptions, all the facts which are illustrated have been made known for the first time by the investigations of your commission, and the series of specimens which illustrate them are, at the present time, therefore, entirely unique.

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* This statement requires a qualification. Our first apparatus was less extensive and had a somewhat different kind of transmitting machinery.

It may also be mentioned that the method of mounting the starfish, lobsters, etc., in a transparent solid medium, was also worked out by a member of the commission for this purpose.

Many of the specimens above enumerated were exhibited at the Pan-American Exhibition, but a large number of new specimens have been added which represent the work done during the last two years. To meet the different requirements of the prospective exhibition, all of the older specimens have been remounted. The relief model of the bay has been completed by the addition of the land above the 100 foot contour line.

All of the specimens prepared for the exhibit will remain the property of your commission, and will be exhibited, as far as possible, in the office of your commission at the Capitol.

FISH COMMISSIONERS OF THE STATES AND TERRITORIES.

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KANSAS.

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Charles E. Oak, Caribou.
A. R. Nickerson, Commissioner Sea and Shore Fisheries, Boothbay Harbor.

MARYLAND.

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Percy Kennett, Helena.

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J. S. Kirkpatrick, Lincoln.
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NEVADA.

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Thomas B. Baxton, Cincinnati.
J. C. Porterfield, Chief Warden, Columbus.
L. J. Weber, McConnelsville.

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Governor, Secretary of State, State Treasurer, Salem.
H. G. Van Dusen, Master Fish Warden, Astoria.

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Barton D. Evans, Chief Clerk, Harrisburg.
John Hamberger, Erie.
Henry C. Cox, Wellsboro.
Andrew R. Whitaker, Phœnixville.
Charles L. Miller, Altoona.

PENNSYLVANIA.

John Hamberger, Erie.
W. E. Meehan, Secretary, Philadelphia.

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Chas. W. Willard, Westerly.
A. D. Mead, Providence.
Wm. P. Morton, Secretary, Providence.
Adelbert D. Roberts, Woonsocket.
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Andrew G. Gugel, Secretary, 339 Carondelet St., New Orleans.
John Dymond, Junior Attorney, 339 Carondelet St., New Orleans.
Harry Gage, Chief Inspector, 339 Carondelet St., New Orleans.
H. C. Smith, Chief Surveyor, 339 Carondelet St., New Orleans.

APPENDIX.

FISHERIES LAWS

OF

RHODE ISLAND,

1904.

COMPILED BY THE
COMMISSIONERS OF INLAND FISHERIES.

GENERAL LAWS.

CHAPTER 1.

The jurisdiction of the commissioners of inland fisheries covers the territorial limits of the State as given in the following two sections of chapter one, and covers all the fisheries of the State except the oyster and scallop fisheries, which are under the jurisdiction of the shell fish commissioners.

SECTION 1. The territorial limits of this State extend one marine league from its seashore at high water mark. When an inlet or arm of the sea does not exceed two marine leagues in width between its headlands, a straight line from one headland to the other is equivalent to the shore-line. The boundaries of counties bordering on the sea extend to the line of the State as above defined.

SEC. 2. The jurisdiction of the State shall extend to, and embrace, all places within the boundaries thereof, except as to those places that have been ceded to the United States, or have been purchased by the United States with the consent of the State.

CHAPTER 171.

Of Certain Fisheries.

SECTION 1. Every person who shall set or draw any seine in any part of the river running from Warren river through the town of Barrington, except that part lying north of the Congregational church building in the said town of Barrington, shall forfeit twenty dollars.

SEC. 2. Every person who shall set or draw any seine or net in Easton's pond in Newport and Middletown for the purpose of catching fish, or shall set any such net or seine in the creeks or inlets of said pond above the bridge at Easton's beach, shall be fined twenty dollars or be imprisoned ten days.

SEC. 3. Every person who shall set or draw any seine or net in Kickamuit river within half a mile from the place called the narrows shall forfeit fifteen dollars.

SEC. 4. Every person who shall erect or make any weir, pot, or other contrivance to obstruct the course of fish across Puncatest, alias Nomquit, pond, or any part thereof, or in any river or stream leading into or out of said pond at any time, shall forfeit ten dollars.

SEC. 5. Every person who shall set any hanging or mesh net in Puncatest, alias Nomquit, pond, or in any river leading into or out of said pond, between the first day of January and the first day of August, shall forfeit ten dollars.

SEC. 6. Every person who shall erect or continue in Palmer's river, above Kelly's bridge, any weir, dam, or other obstruction to prevent the free passage of fish up said river, shall forfeit fifteen dollars for the first offence and ten dollars for every twenty-four hours any such weir or dam or other obstruction shall be continued after the first twenty-four hours.

SEC. 7. Every person not at the time an inhabitant of this State who shall set or draw any seine or net in Palmer's river, above Kelly's bridge, on Thursday, Friday, or Saturday, and every person who shall set or draw any seine or net in said river above said bridge on Sunday, or between the setting and rising of the sun, shall forfeit for each offence fifteen dollars.

SEC. 8. Repealed.

SEC. 9. Repealed.

SEC. 10. Repealed.

SEC. 11. No person shall take any fish with any kind of gill or mesh net, or set any gill or mesh net for the purpose of taking any fish therewith, within one mile from the shore of Block Island, between the first day of June and the first day of November in each year, without first obtaining permission of the town council of New Shoreham; and every person violating any provision of this section shall be fined twenty dollars for each offence; one-half to the use of the complainant and the other half to the use of the town of New Shoreham.

SEC. 12. Any person who shall take any fish with any kind of seine, net, or trap, or set or draw any seine, net, or trap, for the purpose of taking any fish therewith, in any of the fresh water ponds in the town of New Shoreham, except in private ponds owned by one person, shall be fined not exceeding twenty dollars or be imprisoned not exceeding ten days, or be both fined and imprisoned in the discretion of the court.

SEC. 13. The electors of the town of New Shoreham may, in town meeting called for that purpose, enact such ordinances as they may think proper to protect and to regulate the taking of shell-fish and other fish in Great Salt pond, and may impose penalties therefor not exceeding twenty dollars fine and three months' imprisonment for any one offence.

SEC. 14. The electors of the town of Tiverton may, in town meeting called for that purpose, make such regulations for the preservation of the fish, and may exercise such control over the fisheries of Nomquit pond, within the limits of said town, as they may think proper.

Sec. 15. No person shall, between the first Monday in October and the first Monday in January, erect any weir or draw any seine or net for the purpose of catching or obstructing the passage of fish at or within one hundred and sixty rods of the mouth of Pataquamscut river in South Kingstown, nor shall any person erect or put down any weir, standing seine, or trap-seine, or hoop-net of any kind, either within or across said river at any other season of the year.

Sec. 16. Nothing in the preceding section shall be so construed as to prohibit any person from using nets or fishing crafts for the catching of smelts, such as are commonly used in the smelt fishery, between the first day of February and the first day of April, or to prohibit the setting of gill nets for bass in said river or pond; *Provided*, that such nets shall not exceed twenty fathoms in length, nor be set within twenty fathoms of each other, nor south of the dividing line between lands now or formerly of William G, Watson and George W. Crandall, nor within twenty rods of the narrows that connect the upper and lower ponds; nor shall any person maintain any such standing seine or net in the same place for more than twenty-four hours if any other person demands the same place for the purpose of setting a like net or drawing a seine therein.

Sec. 17. Every person who shall violate any of the provisions of the preceding two sections shall be fined not less than twenty dollars nor more than fifty dollars for each offence, and shall forfeit the seine, net, boat, and other apparatus by him used in such violation.

Sec. 18. Every person who shall set any trap or net or draw any seine at any time west of a line drawn from Calf-pasture Point on the north side of Allen's harber to Rocky Point on the south side thereof, or west of a line drawn from Pojack Point on the south side of Potowomut river to Marsh Point on the north side thereof, shall be fined not less than five dollars nor more than twenty dollars; one-half thereof to the use of the complainant and one-half thereof to the use of the State.

Sec. 19. No person shall between the fifteenth day of April and the fifteenth day of June, inclusive of both days, or between the fifteenth day of August and the fifteenth day of December, inclusive of both days, commencing at the rising of the sun on both days, erect any weir or set or draw any seine or net for obstructing, catching, or hauling of fish within half a mile east from Point Judith ponds breach, meaning the breach for the time being into the sea, or within a point on the west side of said breach four rods distant from Joseph Champlin's fish-house, so called, or within said breach, or within any channel leading to said ponds, or any branch thereof from the sea, or within a quarter of a mile of the entrance of such channel into said ponds or branches of said ponds; and whenever the fifteenth day of December happens on Sunday this prohibition shall continue to the rising of the sun on the next succeeding day.

Sec. 20. No weir shall be erected, nor any standing seine or net set, in any part of Charlestown pond, Quonochontaug pond, or Babcock's pond, otherwise known as Brightman's pond, nor across the channel, or in Point Judith's ponds within a quarter of a mile from the following places, namely: Alder Point near where Saukatucket river flows into said ponds; Princes narrows, which connects the upper with the lower ponds; Strawberry hill on Great Island; High Point, so-called, on lands of the heirs of Joseph Sherman, and Gooseberry Hole.

Sec. 21. No person shall, between sunset on the first Monday in April and sunrise on the second Monday in June, erect any weir or net or draw any seine or net for the purpose of catching or obstructing the passage of fish in any part of Point Judith pond south of a line drawn from the most northerly point of Strawberry hill on Great Island to the most northerly point of High Point in said pond.

Sec. 22. No person shall erect any wier or set or draw any seine or net for the obstructing, catching, or hauling of fish within any part of said ponds or any branch thereof, at any time between sunset on the fifteenth day of August and sunrise on the fifteenth day of December.

Sec. 23. No seine or net of any sort shall be used at any time within said ponds or any branch thereof, of over one hundred fathoms in length, nor any standing seine or net of over twenty-five fathoms in length.

Sec. 24. No person shall set any standing seine or net, at any time, within forty rods of any place within said ponds or any branch thereof where another person may have already set his standing seine or net, nor shall any person maintain any such standing seine or net in the same place for more than forty-eight hours if any other person desires to occupy the place.

Sec. 25. Every person violating any provision of the preceding six sections shall be fined not less than twenty dollars nor more than fifty dollars, and shall also forfeit the boat, seine, net, and other apparatus by him used in such violation, one-half of said fine and forfeiture to the use of the person complaining and one-half thereof to the use of the state.

Sec. 26. Every person living without the state who shall take any lobsters, tautog, bass, or other fish within the harbors, rivers, or waters of this state, for the purpose of carrying them thence in vessels or smacks, shall be fined ten dollars for every offence, and shall forfeit all the fish or lobsters so taken.

Sec. 27. Every person who shall take any fish in any stream or fresh pond, except upon his own land, otherwise than by a single hook and line, or who shall take or carry away any fish from any private pond, brook, stream, preserve, or any other place made, constructed, or used for the purpose of breeding or growing fish therein, without the consent of the proprietor or lessee of such pond, brook, stream, or preserve, shall be fined not exceeding twenty dollars or be imprisoned not exceeding thirty days, or be both fined and imprisoned; but nothing herein contained shall be so construed as to authorize the taking of any fish from any pond or stream stocked with fish at the expense of the state.

SEC. 28. Every person who shall take any trout between the fifteenth day of July and the first day of April shall be fined twenty dollars for each offence, and every person who shall take or have in his or her possession any trout less than six inches in length at any time of the year shall be fined twenty dollars for each trout found in his or her possession, but nothing herein contained shall be so construed as to prohibit the taking and sale of trout artificially cultivated in private ponds at any season of the year; *Provided*, that all persons raising brook-trout artificially in private ponds shall use the initials of their names as a brand, which brand shall be put on every box of trout shipped or put on the market by them between the fifteenth of July and the first day of April in each year. All persons raising and disposing of trout as aforesaid shall cause their brand required herein to be registered by the secretary of state.

SEC. 29. All actions for violations of the provisions of the preceding two sections shall be commenced within thirty days after the commission of the offence.

SEC. 30. Every person who shall, by any seine or stop-net, or otherwise, obstruct the channel leading from the sea into Ward's pond, and up through said pond on each side of Watermelon, Gooseberry, or Larkin's islands, shall be fined not less than five dollars nor more than twenty dollars.

SEC. 31. Every person who shall erect any dam, weir, or other obstruction across Mill cove in Warwick, or from the mouth of said cove to the pond of fresh water that runs into said cove, or such streams as run into said pond, or who shall keep up any dam, or weir, or other obstruction therein made, and every owner or occupant of lands adjoining said Mill cove or the stream leading from said pond into said cove who shall permit any such obstruction to be erected or continued in or upon said cove or stream adjacent to his land, at any time between the first day of March and the first day of November, shall forfeit one hundred dollars for each offence.

SEC. 32. Every person who on Saturday or Sunday shall fish in said cove except with a hook and line, or who shall catch or hinder any alewives coming down said Mill cove or said stream, or shall therein at any time set any weir or device to prevent the passage of the fish, shall forfeit ten dollars for each offence: *Provided*, that nothing herein contained shall be so construed as to authorize fishing on Sunday.

SEC. 33. Every person who shall set or draw any seine or net in said Mill cove, or off from the mouth thereof to Long Meadow rocks, or from the mouth thereof to the pond of fresh water which empties into said cove, between the first day of March and the fifteenth day of June, or who shall take any alewives from said pond, or streams flowing into said pond, between the first day of March and the first day of November in any year, shall for each offence forfeit one hundred dollars and the boats, seines, and other apparatus used in the commission thereof: *Provided, however,* that nothing in this chapter shall be so construed as to prohibit any person from fishing for alewives in said cove, or stream running from said pond into said cove, with a bowed net not larger than twelve feet around the mouth of said net, on days other than those excepted in section thirty-two of this chapter.

SEC. 34. There shall be, between the first day of May and the first day of August, a weekly close-time extending from Saturday morning at sunrise to Monday morning at sunrise, during which time no fish of any description shall be taken by weirs, traps, or similar contrivances, from any of the waters of the coast-line of the state and Narragansett bay. If there be any weir, trap, or other stationary contrivances used for the purpose of catching or obstructing the passage of fish in that part thereof where the fish are usually taken, the netting at the mouth of the same shall be floated to the surface of the water so as to effectually close the mouth thereof during the weekly close-time, so that during said time the fish may have a free, unobstructed passage, and no device shall be placed in any part of said limits which shall tend to hinder such fish from running up the waters of such rivers. In case the inclosure where the fish are taken is furnished with a board floor, an opening three feet wide shall be made extending from the floor to the top of the weir, trap, or other contrivances: *Provided, however,* that nothing herein shall be so construed as to apply to the shad and herring fisheries in the tributaries of Narragansett bay.

SEC. 35. The commissioners of inland fisheries shall have a general supervision of all matters relating to the subjects contained in sections eight, ten, twenty-six, twenty-seven, and thirty-four of this chapter, and may make all needful regulations to carry out the provisions of said sections, and shall from time to time examine all the weirs, traps, or other contrivances, with a view of carrying out such regulations as are most beneficial to the people of the state, and shall prosecute for the violation of such regulations or for the infringement of the provisions of any of said sections. They may co-operate with the fish commissioners of other states, and shall make an annual report to the general assembly of their doings, with such facts and suggestions in relation to the object for which they are appointed as they may deem proper. Said commissioners shall be allowed their actual disbursements made in the execution of this chapter.

SEC. 36. Every person who shall violate any of the regulations made by said commissioners under the authority of the provisions of the preceding section of this chapter, or who, during the close-time mentioned in section thirty-four, shall set any weir, trap, or contrivances contrary to such provisions, shall be fined not exceeding one hundred dollars or be imprisoned not exceeding three months, or both, in the discretion of the court before which the offender shall be tried.

SEC. 37. All forfeitures under this chapter shall, where there is no other provision made to the contrary, enure one-half thereof to the use of the town where the offence shall be committed and one-half thereof to the use of the person suing for the same.

CHAPTER 172.

Of the Fishery of Pawcatuck River.

SECTION 1. No weir or pound or other obstructions shall be erected or continued in the channel of Pawcatuck river, dividing the states of Rhode Island and Connecticut, so as to interfere with the main channel of said river, upon penalty of twenty dollars for the first offence, and seven dollars for every twenty hours or any less space of time any such weir or other obstruction shall be continued in the main channel of said river after the first offence.

SEC. 2. No weir or pound shall be erected or continued upon any flat or other part of the bottom of said river, eastward or westward of the aforesaid channel of said river, between the first day of June and the twentieth of March, annually, upon penalty of fourteen dollars for the first offence and seven dollars for every succeeding day such weir or pound shall be continued in said river, from the first day of June to the twentieth day of March, annually.

SEC. 3. No person shall fish with mesh or scoop nets in Pawcatuck river, or any of its branches, after sunset on Friday until sunrise on Monday in each week, from the twentieth day of March to the first day of June, annually, and no person shall use more than one net at a time upon penalty of five dollars for every offence.

SEC. 4. All penalties incurred for violation of any of the provisions of this chapter shall enure one-half thereof to the use of the complainant and one-half thereof to the use of the town where the offence is committed.

SEC. 5. The foregoing provisions of this chapter shall be considered as form-ing a compact with the state of Connecticut, from which the general assembly will not depart until the legislature of the state of Connecticut shall agree with the general assembly of this state to a repeal thereof, alterations therein, or additions thereto.

SEC. 6. If any owner of land adjoining Pawcatuck river in this state shall permit any weir, pound, or other obstruction to be erected or continued upon any flat or bottom of said river, whether done, erected, or continued by himself, servant, lessee, or any other person, by his privity or consent, such owner shall be liable for any such breach or violation of section two of this chapter in the same manner as though the same had been committed by such owner in person.

CHAPTER 174.

Of the Inland Fisheries.

SECTION 1. The governor shall appoint seven commissioners of inland fisheries, who shall hold their offices for three years and until their successors are appointed.

SEC. 2. The commissioners of inland fisheries shall introduce, protect, and cultivate fish in the inland waters of the state, and may make all needful regulations for the protection of such fish, and shall prosecute for the violation of such regulations and of the laws of the state concerning inland fisheries. (They may, in their discretion, from time to time, make experiments in planting, cultivating, propagating, and developing any and all kinds of shell fish; and for the purpose of so doing may from time to time take, hold, and occupy, to the exclusion of all others, in one or more parcels, any portions of the shores of the public waters of the state, or land within the state covered by tide-water at either high or low tide not within any harbor line, and which is not at the time of such taking under lease as a private and several oyster fishery: *Provided*, that the land so held and occupied at any one time shall not exceed three acres. Said commissioners upon taking such land shall forthwith give public notice thereof by advertisement in some newspaper in the county in which said land is situated, which advertisement shall contain a description of said land; they shall also forthwith notify the commissioners of shell fisheries of such taking and shall transmit to them a description of said land, and shall also stake out or otherwise mark the bounds of said land. Said commissioners may make all needful regulations for the protection of the land so taken, and of all animal life and other property within the lines thereof, and shall prosecute the violations thereof.) They may co-operate with the fish commissioners of other states, and they shall make an annual report to the general assembly of their doings, with such facts and suggestions in relation to the object for which they were appointed as they may deem proper. Said commissioners, whenever complaint is made by them, or either of them, for a violation of any regulation made by them as aforesaid, or for violation of any of the provisions of this chapter or of chapters 171, 172, and 173, shall not be required to enter into recognizance on such complaint or become liable for costs thereon.

SEC. 3. The said commissioners shall cause a copy of any regulation made under the authority of the preceding section to be filed in the office of the town clerk of any town in which any waters stocked with fish, or land occupied for experiments under the authority of the preceding section and to which such regulations may apply, may be, and shall also cause a copy of such regulations to be advertised in some newspaper published in the same county.

SEC. 4. Every person who shall violate any of the regulations made by the commissioners of inland fisheries under the authority of the provisions of the preceding three sections, or who shall take any fish, fish-spawn, or any apparatus used in hatching or protecting fish, from any pond, lake, river, or stream stocked with or set apart by said commissioners, or by private parties, for the protection and cultivation of fish with the consent of the town council of the town where such cultivation is carried on, without the consent of such commissioners, or, if the cultivation of fish be carried on by a private party, without the consent of the person cultivating the same, or who shall trespass within the boundaries of any land which may be taken and occupied by said commissioners for their experiments in relation to shell-fish, authorized by section two of this chapter, shall be fined not exceeding three hundred dollars or be imprisoned not exceeding six months, or be both fined and imprisoned in the discretion of the court be fore which the offender shall be tried.

SEC. 5. Every person who shall catch any fish or shall use any seine for catching fish within half a mile from the mouth or outlet of any fishery set apart as is herein provided, and within any waters into which the waters of such fishery are let out, and every person who shall violate any of the provisions of sections seven, eight, and ten of this chapter, shall forfeit for the first offence the sum of fifty dollars, and for every subsequent offence shall forfeit one hundred dollars; and in addition to the penalties herein provided shall forfeit all the apparatus by him used in violation of the provisions of this section.

SEC. 6. Each of the commissoners of inland fisheries may, personally or by deputy, seize and remove, summarily if need be, all obstructions erected to hinder the passage of migrating fish, or which are illegally erected to obstruct or in any way to impede the growth and culture of fish.

SEC. 7. No person shall take or catch fish of any kind from any of the inland waters of the state, set apart by the commissioners of inland fisheries for the cultivation of fish, except at such times and in such manner as is hereinafter provided.

SEC. 8. The prohibition of the catching of fish by hook and line, from fisheries stocked as hereinbefore provided, shall extend and be continued for and during the term of three years from and after the time when such fishery was first established: *Provided, however*, that fish may be caught through the ice only, and with hook and hand-line only, in those ponds set apart for the cultivation of black bass, during the months of December, January, and February, until the expiration of the aforesaid term of three years.

SEC. 9. After the expiration of said three years no black bass shall be taken in any waters of this state, except Sneach pond in the town of Cumberland, and Moswansicut pond in the town of Scituate, between the first day of March and the first day of July in each year, nor at any time except by hook and line as aforesaid. Every person taking any black bass during the time aforesaid, or in any other manner except by hook and line, shall be fined fifteen dollars for each black bass so taken, and every person who shall take or have in his or her possession any black bass less than eight inches in length at any time of the year shall be fined fifteen dollars for each black bass found in his or her possession; and possession by any person of any black bass less than eight inches in length, or during the time aforenamed, shall be evidence that such black bass were taken in violation of this chapter; but nothing herein contained shall be so construed as to prohibit the taking and sale of black bass artificially cultivated in private ponds at any season of the year.

SEC. 10. After the expiration of said three years no fish shall be taken by any person from any waters legally set apart by said commissioners for the cultivation of shad or salmon, or within one mile of the outlet of the streams so set apart, except from and after the fifteenth day of April until the fifteenth day of July, or at any time except by hook and hand-line, or by not less than three-inch mesh nets or seines.

SEC. 11. One half of the fines and forfeitures recovered for violation of the provisions of this chapter shall accrue to the complainant and one-half thereof to the use of the state.

SEC. 12. The commissioners of inland fisheries may take fish from the fisheries hereinbefore referred to, for any purpose connected with fish culture or for scientific observation.

SEC. 13. Each of said commissioners may, in the discharge of his duties, enter upon and pass over private property without rendering himself liable in an action of trespass.

Sec. 14. The commissioners of inland fisheries shall be allowed their actual disbursements made in carrying into effect the provisions of this chapter.

CHAPTER 175.

General Provisions for the Protection of Fisheries.

Section 1. Every person who shall throw into or deposit in, or cause to be thrown into or to be deposited in, any of the public tide-waters of the state or upon the shores of any such tide-waters any fish-offal or any water impregnated with fish, unless the same be filtered in such manner as may be determined by the town council of the town wherein such deposit shall be made, and every person who shall cause any deleterious substance resulting from the smelting or manufacture of copper or from other manufactures, or from other sources, which is destructive to fish or which repels them from coming into the said public waters, or which shall do anything which tends to drive them therefrom, to be emptied, deposited, or run into the said public waters, shall forfeit one hundred dollars.

Sec. 2. Every vessel, craft, boat, or floating apparatus employed in the procuring of fish-oil, or in the dressing of bait for the mackerel fisheries, or the dressing of fish for other purposes, in violation of this chapter, shall be liable for any forfeiture and costs resulting from prosecution hereunder; and the same may be attached on the original writ and held, as other personal property attached may be held, to secure any judgment which may be recovered in any action brought to enforce any such forfeiture; and any person, upon view of any offence in violation of this chapter, may seize and detain any vessel, craft, boat, or floating apparatus, the same to be detained for a period not exceeding six hours.

Sec. 3. Every person who shall boil any menhaden fish, or press any fish for the purpose of extracting oil therefrom, on board of any vessel on any of the public tide-waters, shall be fined not exceeding fifty dollars.

Sec. 4. Any person who shall wilfully place any brush, trees, or limbs of trees in any of the waters of Charlestown pond shall be fined not more than twenty dollars nor less than five dollars for each offence; and all fines under this section shall enure one-half thereof to the use of the complainant and one-half thereof to the use of the town of Charlestown.

PUBLIC LAWS.

CHAPTER 969.

AN ACT IN SUBSTITUTION OF CHAPTER 857 OF THE PUBLIC LAWS, PASSED AT THE JANUARY SESSION, A. D. 1901, ENTITLED "AN ACT FOR THE BETTER PROTECTION OF THE LOBSTER FISHERIES."

SECTION 1. Every person who catches, takes, or has in his or her possession any lobster less than nine inches in length, measuring from the end of the bone projecting from the head to the end of the bone of the middle flipper of the tail, the lobster extended on its back its natural length, and every person who has in his or her possession any cooked lobster less than eight and three-quarters inches in length, and every person who has in his or her possession any female lobster bearing eggs or from which the eggs have been brushed or removed, shall be fined five dollars for every such lobster; but a person catching or taking any such live lobster and immediately returning the same alive to the water from which taken shall not be subject to such fine. The possession of any such lobster, cooked or uncooked, not of the prescribed length, shall be *prima facie* evidence to convict.

SEC. 2. All lobster pots, cars, and other contrivances used for the catching or keeping of lobsters shall be plainly marked with the name or names of the owner or owners. And every person who shall not have his lobster pots, cars, or other contrivances so marked shall be fined twenty dollars and be imprisoned not more than thirty days for each such offence. And all pots, cars, and other contrivances used contrary to the provisions of this section shall be seized by the officer engaged in the enforcement of this law, and said property shall be forfeited.

SEC. 3. There shall be, between the fifteenth day of November and the fifteenth day of April next succeeding, a close time, during which time it shall be unlawful for any person to set or keep, or cause to be set or kept, within any of the waters of this state, any pots or nets for the catching of lobsters, or to take any lobsters during such close time. Every person violating any of the provisions of this section shall be fined twenty dollars and be imprisoned not more than thirty days for each such offence.

SEC. 4. No person shall be allowed to set or keep, or cause to be set or kept, within any of the waters of the state, any pots or nets for the catching of lobsters who has not had his home and residence in this state for the period of one year next preceding the time of his catching such lobsters. Every person violating any of the provisions of this section shall be fined twenty dollars and be imprisoned not more than thirty days for each such offence.

SEC. 5. Every person, except the commissioners of inland fisheries and their deputies, who shall lift or raise any pot or net set for the catching of lobsters, without the permission of the owner or owners thereof, shall be fined ten dollars for each such offence.

SEC. 6. Every person who mutilates a lobtser by severing its tail from its body, or has in his or her possession any such tail or tails of lobsters before such lobsters are cooked, shall be fined five dollars for each such offence; and in all prosecutions under this act the possession of any such tail or tails of uncooked lobsters shall be *prima facie* evidence to convict.

SEC. 7. The commissioners of inland fisheries shall appoint at least two deputies, whose duties shall be the enforcing of the provisions of this act. Each of said deputies appointed as aforesaid shall be, by virtue of his office, a special constable, and as such deputy may, without warrants, arrest any person found violating any of the provisions of this act and detain such person for prosecution not exceeding twenty-four hours. Said deputies shall not be required to enter into recognizance or become liable for costs.

SEC. 8. For the purpose of enforcing the provisions relative the protection of lobsters, the commissioners of inland fisheries and their appointed deputies may search in suspected places, or upon any boat or vessel that they may believe is used in the catching or transporting of lobsters, and may seize and remove lobserts taken, held, or offered for sale in violation of the provisions of this act.

SEC. 9. Fines incurred under any of the provisions of this act shall enure one-half thereof to the use of the complainant and one-half thereof to the use of the state.

SEC. 10. The several district courts shall have concurrent jurisdiction with the common pleas division of the supreme court over all offences under this act, and to the full extent of the penalties therein specified; parties defendant, however, having the same right to appeal from the sentences of said district courts as is now provided by law in other criminal cases.

SEC. 11. Sections eight, nine, and ten of Chapter 171 of the General Laws, entitled "Of certain fisheries," and also Chapters 316 and 857 of the Public Laws, and all acts and parts of acts inconsistent herewith, are hereby repealed.

SEC. 12. This act shall take effect upon and after its passage.

CHAPTER 1006.

AN ACT IN RELATION TO TRESPASS ON LAND.

SECTION 1. Whoever shall enter upon the land of another for the purpose of either shooting, trapping, or fishing when the same shall be conspicuously posted by the owner or occupant with notices that shooting, trapping, or fishing is prohibited thereon, or whoever shall without right mutilate, destroy, or remove any such notice, shall be fined not exceeding twenty dollars.

SEC. 2. All acts or parts of acts inconsistent herewith are hereby repealed, and this act shall take effect July 1st, 1902.

CHAPTER 1132.

AN ACT PROHIBITING THE TAKING OF FISH OF ANY SPECIES FROM THE WATERS OF GORTON'S LAKE, SO-CALLED, IN THE TOWN OF WARWICK, R. I., BEFORE APRIL 1, 1906.

SECTION 1. Every person who shall take fish of any species from the waters of Gorton's Lake; so-called, in the town of Warwick, before the first day of April, A. D. 1906, shall be fined not exceeding one dollar for the first offence, and not to exceed ten dollars for each subsequent offence.

SEC. 2. This act shall take effect immediately.

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